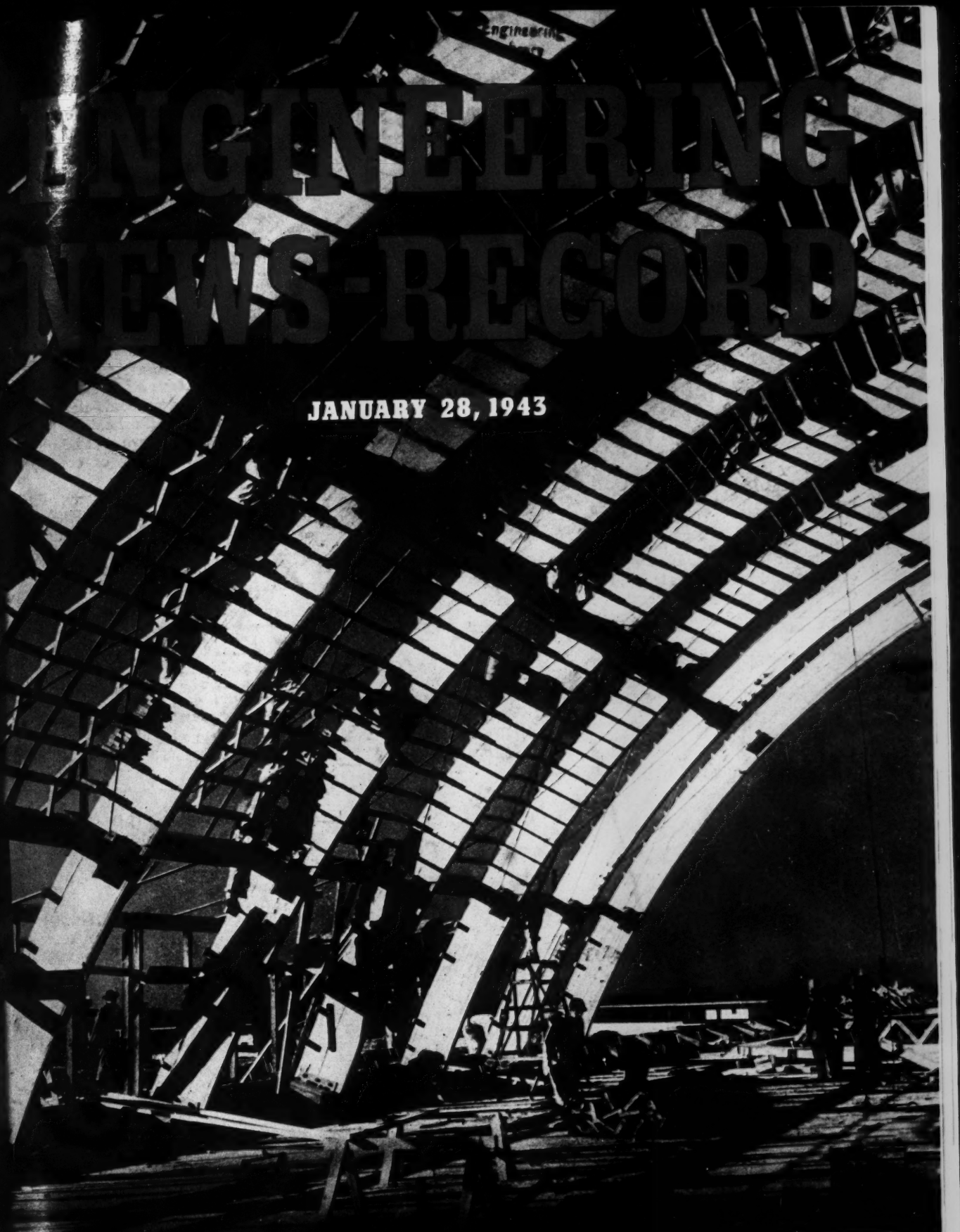
ENGINEERING NEWS-RECORD

JANUARY 28, 1943



Laminated timber arches support wood roof over 120-ft. span di

UNIV OF MICHIGAN
GENERAL LIBRARY
ANN ARBOR MICH

Now Serving in Two New Chapels for the Armed Forces . . . RADIANT HEATING and BYERS WROUGHT IRON

In war, as in peace, Radiant Heating continues to demonstrate its adaptability and versatility. The illustration shows it being installed in one of two new chapels, built for the military forces.

The chapels are 131 feet by 50 feet. The 2½-inch supply lines, 2-inch headers, and ¾-inch coils are all wrought iron, laid on a gravel base and covered with a concrete slab 4 inches to 5 inches in thickness. The system was designed by F. E. Markel, Engineer, Mechanical Department of Robert and Company, Architects. Byers Wrought Iron Pipe was used.

Radiant Heating is receiving particular attention from active architects and engineers today, because of its economy in material requirements. A comparative check recently made on a projected job revealed that metal needed (exclusive of boiler) for a hot water system was 1425 lbs.; for a steam system, 977 lbs.; and for a Radiant Heating system, only 727 lbs. With conservation so important, the ability of Radiant Heating to do the job with *less* makes it an invaluable tool. Further, several Radiant Heating users have reported substantial reductions in comparative fuel requirements—another advantage of particular value today.

Questions of availability and delivery naturally arise in connection with all jobs today, when allocations must be made on the basis of greatest individual contribution to war effort. When you have such a question, we urge that you do not depend on rumor or hearsay, but contact a Byers Field Service Representative, the nearest District Office, or the Home Office in Pittsburgh. You can thus be sure of an authoritative answer.

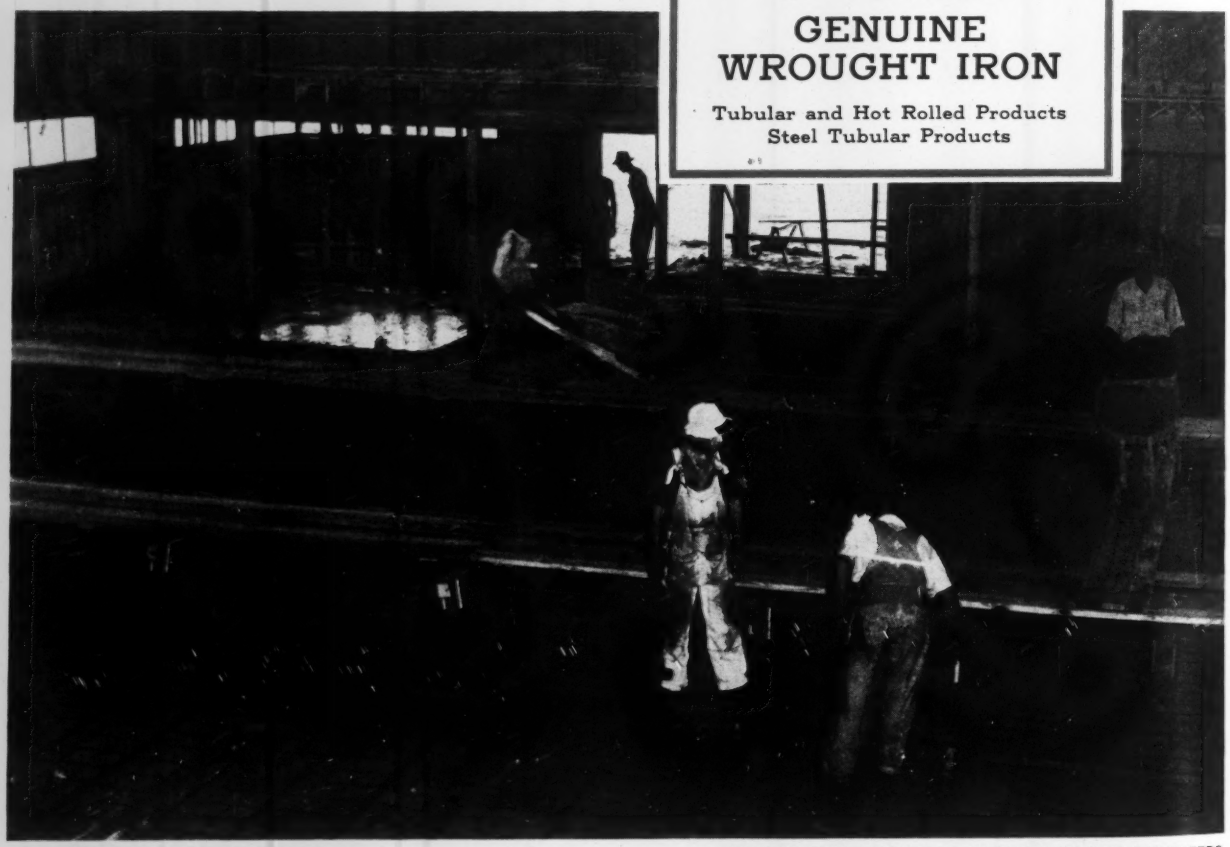
If you do not have our technical bulletin, "Byers Wrought Iron for Radiant Heating Installations" . . . or if any of your associates who are concerned with heating do not have one . . . we will be glad to send you a copy or copies, on request.

A. M. Byers Company. Established 1864. Offices in Pittsburgh, Boston, New York, Philadelphia, Washington, Chicago, St. Louis, Houston, Seattle, San Francisco.

Corrosion costs you MORE than Wrought Iron

LOOK FOR THE PIPE WITH THE RED SPIRAL STRIPE

BYERS
GENUINE WROUGHT IRON
Tubular and Hot Rolled Products
Steel Tubular Products



CHAPELS FOR THE ARMED FORCES

ROBERT AND COMPANY · ARCHITECTS AND ENGINEERS

ENGINEERING NEWS-RECORD

Devoted to Buildings, Sewers, Waterworks, Bridges, Roads, Dams, Foundations, Earthwork, Flood Control, Public Works, Shipbuilding, Irrigation, Canals, Railroads

McGRAW-HILL PUBLISHING COMPANY, INC.

Publication Office: 99-129 North Broadway, Albany, N. Y. • Editorial and Executive Offices: 330 West 42nd Street, New York

JOHN ABBINK, *Publisher*

WALDO G. BOWMAN, *Editor* ALBERT E. PAXTON, *Manager*

Vol. 130 JANUARY 28, 1943 No. 4

COMING NEXT

• ANNUAL REVIEW NUMBER—more than 60 pages of text and illustrations—including a group of articles depicting activities of American engineers and constructors around the globe as seen through the eyes of leading authorities.

The Army's Corps of Engineers and the Navy's Seabees are extending their activities to every actual and potential battle front. Our Ferry Command is using airports across Africa built by Pan-American Airways. Sanitation developments in South America are brewing under the leadership of the Coordinator of Inter-American Affairs, and the open links in the highway from Texas to Panama are rapidly being closed. Each of these significant operations will be the subject of an article.

And, as in previous years, developments and prospects in the various fields of civil engineering and construction will be covered in articles by the editors. This, too, is the issue that contains the annual statistical review of construction and the photographic survey of outstanding accomplishments.

LOOKING AHEAD

• One of the most important war-inspired innovations is an all-precast, reinforced-concrete design — frame, walls, floors and roof—for industrial plants. Not only does the design afford a 60 percent saving in steel over a similar steel-frame structure, but offers several other advantages likely to make this type of construction standard practice in the future. Design and construction will be described in ENR for Feb. 25.

• Newest development in the field of sewage and industrial waste treatment is vacuum flotation. How the process works and what it accomplishes will be described by A. J. Fisher, development engineer, The Dorr Co., who analyzes the results obtained in laboratory trials and plant installation.

• One of the few major bridge projects of 1942 was the Charter Oak span across the Connecticut River at Hartford. It's central 270-300-270 ft. continuous girder unit contains the longest plate girders in the U. S. The design of this structure will be described in *ENR* for Feb. 11.

PAGE

The Week's Events 27
Editorials 36
Steel Fabrication Methods at Calship 38
Designing Efficiency into a War Plant 43
Navy Camp Built from Non-critical Materials 46
How Flight Strips Are Being Built 50
Engineering Schools in the War 55
Navy Builds Prestressed Concrete Fuel Tanks 57
Contact Aeration in Sewage Treatment 60
Timber Tower for 50,000-Gal. Tank 65
Flexible Pavement Design 66
From Field and Office 70
Book Notes and Reviews 72
New Aids to the Constructor 78
Manufacturers' Activities 84
New Trade Publications 88
Men and Jobs 92
Meetings 96
Construction Reports 103

Number of copies of this issue printed: 36,104

CHANGE OF ADDRESS

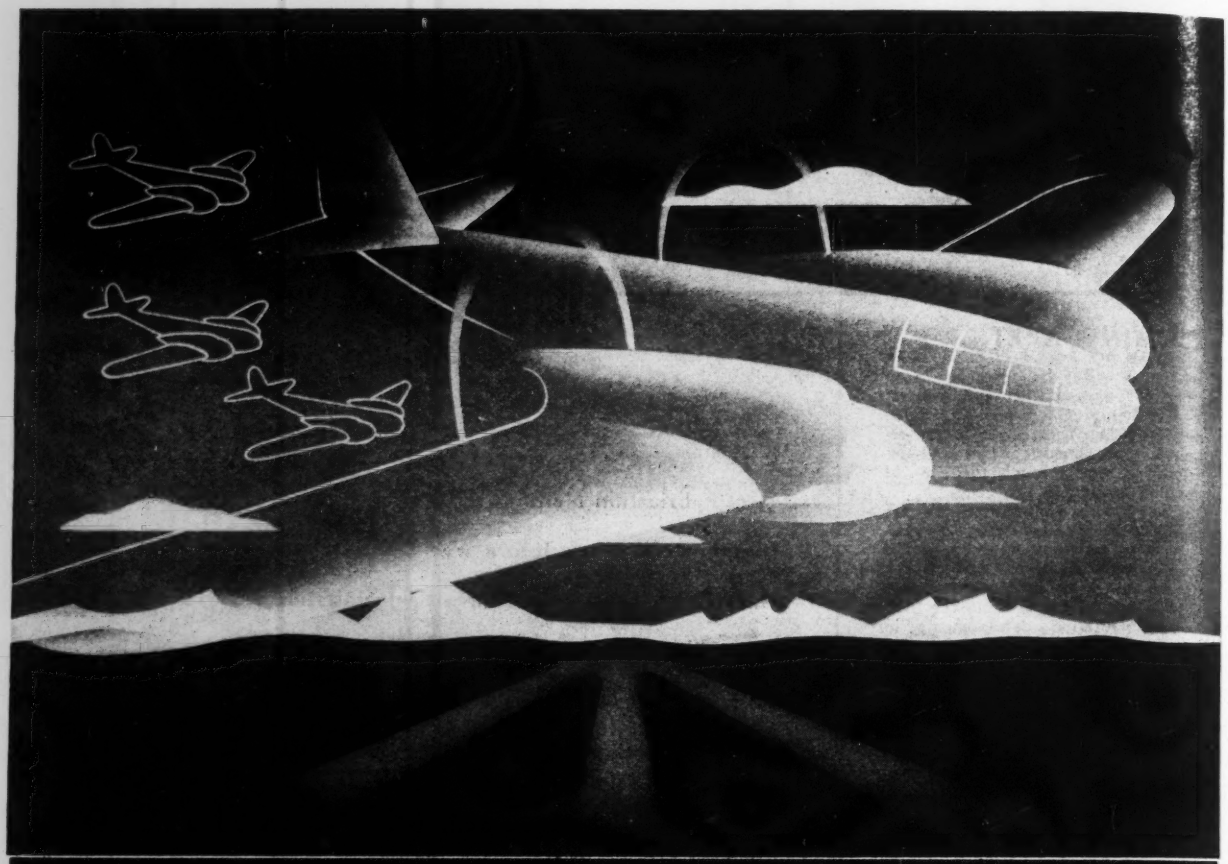
McGRAW-HILL PUBLISHING COMPANY
330 West 42d Street, New York, N. Y.

Director of Circulation:
Please change my address on Engineering News-Record

From .....

To .....

Signed .....



Preview of a busy airport

How would you get the hangars and buildings up quickly for Uncle Sam? How save time in wartime . . . especially in the middle of winter?

THIS airport-in-the-making will be an important link in the nation's chain of military fields. But how to get the finished structures off the blueprints quickly? The weather is cold for concreting. Time is short.

Here's a natural for Atlas High-Early cement. It's the type of wartime job that this product has been speeding for industry, war housing, military roads, naval bases, and army camps.

And in using this cement to speed foundations, structural supports, floors, walls and ramps, and finish the last runway for this airport, consider the other advantages in addition to time-saving which Atlas High-Early often makes possible—savings in lumber and fuel—savings in labor, in release of equipment such as tarpaulins and salamanders more quickly for new work, in earlier use of concrete, and earlier occupancy by owner.

If your essential job is a "Rush" (and what wartime job isn't?), then look to Atlas High-Early cement to give you serviceable, durable concrete several times faster than standard portland cement. Universal Atlas Cement Company (United States Steel Corporation Subsidiary), Chrysler Building, New York.

CHECK ON ATLAS HIGH-EARLY
for Wartime Construction

Atlas High-Early cement gains strength rapidly —produces serviceable concrete in one-fifth the usual time on some jobs.

So it—

1. ***Permits earlier use*** of concrete, and thus gives owner earlier occupancy.
2. ***Saves manpower*** when such conservation is needed most—releases men for new jobs more quickly.
3. ***Conserves lumber.*** Forms may be stripped sooner—often in 24 hours instead of from 3 to 5 days—and re-used. Hence fewer sets of forms may be needed, saving time, labor, and lumber.
4. ***Shortens time required for protection and curing*** as much as 70%. This saves fuel and releases tarpaulins and salamanders for other work.
5. ***Reduces overhead*** by saving time, manpower and equipment.

ENR-H-51

OFFICES: *New York, Chicago, Albany, Boston, Philadelpia, Pittsburgh, Minneapolis, Duluth, Cleveland, St. Louis, Kansas City, Des Moines, Birmingham, Waco.*

SAVE TIME IN WARTIME WITH

Atlas High-Early Cement

A UNIVERSAL ATLAS PRODUCT

The Week In Engineering and Construction

ENGINEERING NEWS-RECORD • JANUARY 28, 1943 • VOLUME 130 • NUMBER 4

Civil engineers limit meeting to two days of active sessions

American Society of Civil Engineers learn of new soil classification for airfield construction, of new developments in sewage treatment and of housing trends

Active and well attended sessions characterized the 90th annual meeting of the American Society of Civil Engineers held in New York Jan. 20-21. Though the meeting was limited to two days instead of the normal three and one-half days because of war conditions, attendance was slightly over that of last year, being 1,650 as compared to 1,603.

Economic matters discussed

The society's board of direction devoted much of its time to consideration of means for clarifying the position of engineering firms and architect-engineers on war projects with respect to government contracts and the possible effect of the Fair Labor Standards Act on the final cost of their work, also to employment condition among engineers. Howard F. Peckworth, field representative of the society, reported that he had traveled about 14,000 miles since March looking into employment conditions and assisting engineering employees in adjusting questions as to pay and working conditions.

The board committee on unemployment of civil engineers reported that engineering employment on war construction passed its peak in August, 1942, and that by April, 1943, a very large part of the members heretofore employed on war construction will be unemployed or will have been absorbed into other lines of war work. The committee recommended active study of possible fields of work for engineers released from construction jobs and close cooperation with the recently created national organization known as the Committee on Economic Development.

Emergency steel code approved

Upon the recommendation of the executive committee of the structural division, the board of direction gave its approval to the War Production Board's "National Emergency Specifications for the Design, Fabrication and Erection of Structural Steel for Buildings." On similar recommendation, it did not approve the American Standards Association building code requirements for structural steel on the assumption that the higher stresses called for in the WPB code will be retained in building codes after the war, thus outdating the prosposed A.S.A. code.

The board went on record as favoring the maintenance of basic engineering training at a high level during the war and post-war period, and urged government agencies to see that a sufficient number of students of superior qualifications be maintained in engineering schools to meet the war and post-war needs of the engineering profession. It urged that control in engineering school over educational and training procedures be left in the hands of the administrative and teaching staffs; it opposed current attempts to convert liberal arts and non-technical curricula into so-called engineering courses.

Departing from a long standing tradition, the society, at the opening session of the annual meeting, conferred honorary membership on two relatively young engineers who have attained notable distinction in military service, Lieut. General Brehon B. Somervell, Commanding General, Services of Supply, U. S. Army, and Rear Admiral Ben Moreell, Chief, Bureau of Yards and Docks, U. S. Navy. Also honored were Alonzo J. Hammond, consulting engineer, Chicago; Lawrence M. Lawson, commissioner, International Boundary Commission, United States and Mexico; and Sherman M. Woodward, chief water control engineer of the Tennessee Valley Authority.

The Norman Medal this year was

(*Continued on p. 31*)

A.S.C.E. meetings to be curtailed

A.S.C.E. meetings during 1943, in addition to the annual meeting, are to be limited to an annual convention to be held at some point on the Pacific Coast in July if conditions permit. The board of direction voted to eliminate spring and fall meetings of the society. The board will hold its spring meeting in Dallas at the time of the meeting of the Texas Section. Division meetings and local section conferences will be curtailed correspondingly to reduce travel.

WPB creates office of power director

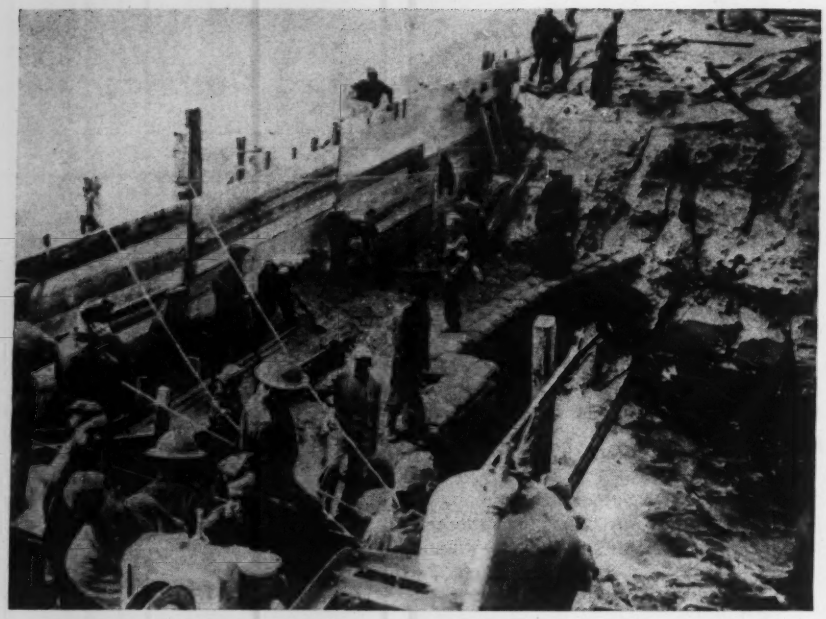
War Production Board Chairman Donald Nelson last week announced creation of the Office of Power Director, and the appointment of J. A. Krug as its head, to take over complete responsibility within WPB for electric power, gas, water and communications.

The Office of Power Director will include the present WPB Power Division, and the Communications Equipment Division. Also transferred are the functions and responsibilities of the Facilities Bureau and the Resources Agencies, in so far as they deal with electric power, gas, water and communications. Mr. Nelson said that on all policy matters the power director will report directly to him, while reporting as to administrative matters to the program vice chairman.

All WPB orders affecting utilities will be issued by the power director. Pursuant to determinations of the Requirements Committee, the power director's authority includes approval of projects, allocation of materials and critical components, within the power and communications fields and allocation and rationing of utilities services.

The Office of Power Director will also have the status of a Claimant Agency before the Requirements Committee on a level with the Army, Navy, Office of Rubber Director and others. The office will also be a liaison between WPB and other government agencies that are interested in the utilities under its control.

Purpose of the arrangement, Nelson said, is to fit all expansion programs together into an orderly and integrated construction program that can be carried out in the time available.



Enemy-wrecked harbor is repaired by engineers

The reconquest of North Africa by the British 8th Army is not entirely a matter of swift-moving tanks and planes.

Here British engineer troops are hard at work repairing the outer harbor wall at Banghazi, Libya, damaged by the enemy as he retreated from the once strongly held port.

Crude wood and sandbag barricades are being used to block off the sea while concrete is placed in the seawall.

Complete first leg of "big inch" oil pipeline

The final link in the 551-mi. oil pipeline from Longview, Tex., to Norris City, Ill., was completed at 4 a.m. January 21, when the last section of the 24-in. pipe was put down on the bed of the Mississippi river.

The section was rushed to completion after a sudden rise of the river tore out 600 ft. of the pipe recently (*ENR*, Jan. 14, p. 20). B. E. Hull, general manager of War Emergency Pipelines, Inc., said materials used in the original river section were salvaged before the final section was laid.

Work on the second stage of the pipeline—an 800 mi. extension from Norris City to the Philadelphia, Pa., area—started in August and is scheduled for completion in late June or early July.

The Longview-Norris City section, built at a cost of $35,000,000, will have a capacity of 300,000 barrels of crude oil daily, although it is not expected to reach full carrying capacity for several months. Oil is now being pumped into the line, and loading of tank cars at Norris City will start about Feb. 10.

Meanwhile, the 185-mi. Carrabelle-Jacksonville oil pipeline (*ENR*, Sept. 17, 1942, p. 397), spanning the northern part of Florida, has been completed and a header of oil is now being pumped from the Gulf Coast port to Jacksonville.

ACI cancels 39th annual meeting as war measure

The 39th annual convention of the American Concrete Institute, scheduled for Feb. 17 and 18 at Chicago, has been cancelled because of "general preoccupation with necessities of war" and heavy demand upon means of transportation.

In its place, the institute's board of direction will hold a one-day meeting on Feb. 17 at the Palmer House Hotel in Chicago, at which meeting honors will be awarded, new officers installed and various yearly reports received and approved.

• • •

Wyoming appoints acting highway superintendent

The Wyoming highway commission has announced the appointment of C. F. Seifried as acting state highway superintendent, to fill the position made vacant by the resignation of Frank Kelso (*ENR*, Dec. 31, 1942, p. 892).

Mr. Seifried, a former highway superintendent, has been chief highway engineer for the past four years. He will continue to hold his engineering post along with his new duties.

Mr. Seifried has been with the department for more than 23 years, having joined it in August, 1919.

Bakenhus new president consulting engineers

The American Institute of Consulting Engineers will be headed during 1943 by Rear Admiral R. E. Bakenhus (CEC) USN, retired, of New York, with Alonzo J. Hammond, of Chicago, as vice president. Election of these two officers, as well as re-election of James Forgie of New York as treasurer and Philip W. Henry of New York as secretary, was the first order of business when the Institute's newly-constituted Council met last week, following the annual dinner meeting in New York on Jan. 18.

At this meeting the three new members of the nine-man Council, who are elected each year by the membership, were announced. These are Herman F. Doeleman, structural and architectural engineer of Baltimore, Irving V. A. Huie, New York City commissioner of public works, and Charles F. Scott, professor of electrical engineering at Yale University.

Feature of the dinner meeting was a discussion of "The Far Eastern Problem," by Maj. Gen. Frank R. McCoy, U. S. Army retired.

Admiral Bakenhus, who succeeds Malcolm Pirnie of New York as president, has been a practicing consulting engineer in New York since his retirement from the Navy in 1937, where he had served since 1901, having been commissioned a lieutenant (j.g.) in the Civil Engineering Corps at that time. Public works officer at numerous navy yards, throughout his long service he was also assistant chief of the Bureau of Yards and Docks from 1918 to 1923, and for one year was acting chief of the bureau.

• • •

British shipyards increase use of welding technique

Although the process of welding in construction of ships in Great Britain is still used to a very small extent in comparison with its use in the United States, its popularity is growing in the United Kingdom, according to the British Supply Council.

In support of the use of electric welding, the Admiralty has made arrangements in conjunction with the Glasgow Corp. for courses of three weeks duration on shipyard welding methods and practice to be held at Stowe College School of Engineering in Glasgow.

The courses include demonstration welding lectures given by a number of persons prominent in the field, and practical welding using both d.c. and a.c. equipment, including an a.c. 600-amp. multi-operator plant.

Wolman sees postwar sanitation needs offering big challenge to engineers

New York State Sewage Works Association convenes with national leaders in sanitation. E. J. Smith, of Niagara Falls, becomes president

Public health and sanitation projects on a vast scale, both in this country and throughout the world, will be undertaken in the postwar period, according to Abel Wolman, professor of sanitary engineering, The Johns-Hopkins University, and president of the Amerian Water Works Association.

In making this prediction at the annual meeting of the New York State Sewage Works Association, on January 22, Mr. Wolman said that not only does there exist a backlog of long-deferred needs to be met in the United States, but there likewise is much to be done in foreign lands.

It is conceivable, he said, that this country may finance a large part of the international program on a reimbursable basis. How much is done, however, will not be dependent on our aid alone because all of the foreign nations in the battle areas will be faced with the immediate necessity of reestablishing war-damaged community facilities.

"In this country," said Mr. Wolman, "the sanitary engineer must become a leader in courageous short-circuiting of artificial legal and political restrictions if stream pollution abatement and other public health measures are to be effective." In this respect he was making a plea for intermunicipal and regional consideration of sanitation problems, the boundaries of which seldom are the same as those established for political purposes.

Timed to follow the sessions of the American Society of Civil Engineers, the New York State group played host to many national figures in the engineering field. In addition to Mr. Wolman, the meeting was attended by Ezra B. Whitman, president-elect of the Society, and George T. Seabury, executive secretary.

Charles Gilman Hyde, professor of sanitary engineering, University of California, who participated in a symposium on the influence of war in sanitary engineering, said that a real danger to the profession existed in the behavior and output of sanitary engineers who were not fully competent, but have been placed in responsible posts because fully qualified men were lacking.

In the same symposium George J. Schroepfer, president of the Federation of Sewage Works Associations, reported that plant operators were faced with perplexing problems involving loss of personnel and securing repair and maintenance parts. William C. Piatt, consulting engineer, of Durham, N. C., said that the efforts of sanitarians had made Army life safer than civilian living so far as freedom from disease was concerned. Charles A. Holmquist, chief engineer of the New York State Health Department, reported that war demands had taken almost 50 percent of the personnel from state health departments, at a time when their duties had increased manyfold.

Technical developments

Elimination of critical materials in the design of sewage disposal projects was outlined by Paul Langdon, consulting engineer with Greeley & Hansen, Chicago. Use of steam to heat sludge and thus eliminate the need for metal heating coils, and the installation of a simple wooden scraper in sedimentation tanks, manually operated, were described.

Vacuum flotation of sewage and industrial wastes, a new development in processing, was outlined by A. J. Fisher, of The Dorr Co. This will be described in a forthcoming article.

Experiences at Army camps with grease removal, which revealed that flotation coupled with sedimentation provided 20 percent greater removal than flotation alone, were outlined by Capt. Rolf Eliassen, of the North Atlantic Division, Corps of Engineers. Wellington Donaldson, director, bureau of sewage disposal, New York City, reported that skimmings from four plants produced 50 tons of grease monthly. Tenative plans have been made to recover and sell this material.

Officers and medallists

Succeeding Charles R. Velzy as president of the association was E. J. Smith, superintendent of sewage treatment, Niagara Falls. William H. Larkin, district engineer of the New York State Health Department, was elected vice-president. A. S. Bedell, chief, bureau of waste disposal, also of the state health department, was reelected secretary-treasurer.

Earle Phelps, professor of sanitary science, Columbia University, and John G. Bevan, of Guggenheim Brothers, New York City, jointly received the Kenneth Allen memorial award of the association for their paper on laboratory studies of the Guggenheim bio-chemical process of sewage treatment.

• • •

Close N. Y. vehicle tube during late night hours

To conserve electric power and manpower, the New York City Tunnel Authority announced last week that beginning Feb. 1 the Queens Midtown tunnel will be open to traffic daily only between 6 a.m. and 12 o'clock midnight.

Commissioner William H. Friedman said that continuing difficulty of holding needed police and service employees for the tunnel had dictated that a survey be made to determine the hours most important for traffic purposes. As a result of this study, the commission decided on the closing hours noted. The tunnel authority said that with hardly any inconvenience to the public, it could conserve 22 percent of its manpower with the indicated curtailment.

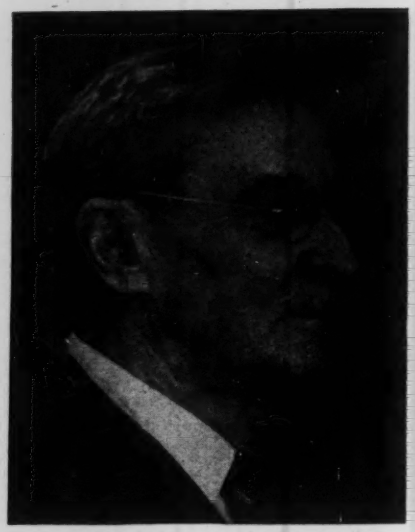
Eased rules aid private housebuilding

The War Production Board acted this week to make private housing construction more attractive to builders, by easing somewhat the rigid maximum standards established last October for priority-aided houses. Builders have been complaining that the housing standards forced the construction of a house of such low quality that it was relatively unsalable and would have little value after the war.

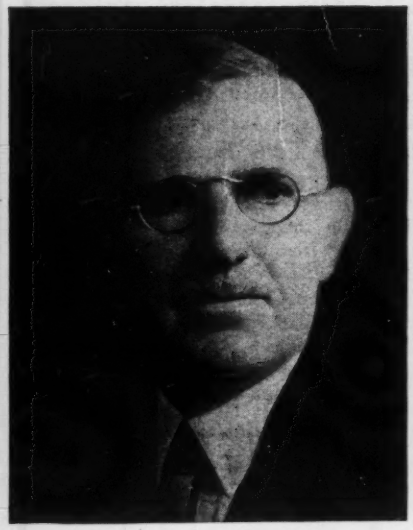
Major change made to meet these objections is a 10 to 15 percent increase in permitted floor area. In addition, the restrictions on lumber use have been relaxed in several respects. This is considered feasible, in part, because it is believed that the large military demand for heavy timbers has increased the supply of side cut lumber. Hence, use of softwood for flooring and sub-flooring is now permitted and the area in which wood-frame construction is forbidden is narrowed. Wood frame construction may be started during the first three months of 1943 in New Hampshire, Vermont, Wisconsin, Iowa, and North and South Dakota. It is still forbidden in 17 other states, permitted in the West Coast and Southeast lumber-producing areas. In the forbidden areas, construction is limited to masonry types.

In a similar move, WPB has temporarily relaxed restrictions on manufacture of eight types of bathroom plumbing fixtures. Manufacturers, until March 15, are permitted to make up fixtures from materials frozen last June. Thereafter, it is expected that cast iron fixtures will be available.

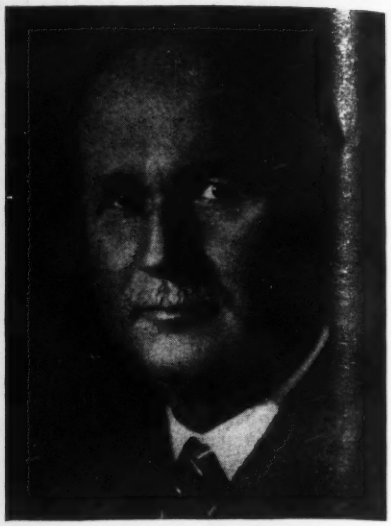
These moves form part of a general tendency visible in Washington the past month or more to go rather easier on the civilian than might have been expected in the light of the "all-out" talk current last year. Feeling now is that restrictions on civilian production have gone about as far as the country will stand, may even have to be relaxed here and there.



Sherman M. Woodward, educator and consulting engineer, is now chief water control planning engineer for the Tennessee Valley Authority. He served from 1896 to 1904 as professor of mathematics and mechanics at the University of Arizona; and from 1908 to 1935 as professor of mechanics and hydraulics at the University of Iowa. In addition to educational work, Mr. Woodward acted as consulting engineer to many organizations, including the Miami Conservancy District at Dayton, O. and the Chicago Sanitary Commission.

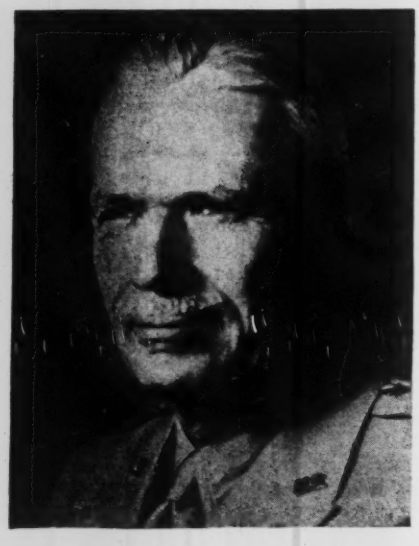


Lawrence M. Lawson, in his capacity as commissioner for the United States on the joint U. S.-Mexico International Boundary Commission has combined his talents as an engineer with exceptional ability as a diplomat and administrator. A graduate of Leland Stanford University, he served as an engineer for the Department of the Interior from 1903 to 1927, when he was transferred to the Department of State as commissioner. Among many agreements he negotiated was that involving straightening and canalizing the Rio Grande River.



Alonzo J. Hammond, past president (1933) of the society, has had a long and varied engineering career. His early work was on railways, power and municipal operations. He served Chicago in many capacities and in 1914 became consulting engineer and later assistant chief engineer on the Chicago Union Station. From 1923 to 1927 he was chief engineer for James O. Heyworth and Mellon-Stuart Co. Since 1927 he has been in consulting practice. Recently, he has been an adviser to the War Department on contracts.

Lt. Gen. Brehon B. Somervell, Commanding General, Services of Supply, U. S. Army, is widely known as an engineer and administrator. A West Point graduate in 1914, General Somervell helped organize the 15th Engineers (Ry.) in 1917, later became a staff officer of the 89th Division in France, and served with the Army of Occupation until 1920. Among his many accomplishments is outstanding service as Works Progress Administrator for the City of New York. Late in 1940, he took charge of the Construction Division of the Quartermaster Corps.



Am. Soc. C. E. names Honorary Members

Five outstanding engineers honored by society at its 90th annual meeting in New York

Rear Admiral Ben Moreell, Chief of the Bureau of Yards and Docks and chief of the Civil Engineer Corps, U. S. Navy, started his naval career in 1917 when he was commissioned a lieutenant in the Civil Engineer Corps. Serving through the first world war in many capacities, he became executive officer to the engineer in chief of the Haitian Department of Public Works in 1920, and served as public works office at the Navy Yard in Pearl Harbor in 1937. In December of that year, he became a rear admiral and took command of the Bureau of Yards and Docks.

Am. Soc. C. E. holds 90th annual meet in N. Y.

(*Continued from p. 27*)

awarded to Karl Terzaghi, lecturer at Harvard University; the J. James R. Croes Medal to Charles F. Ruff, sanitary engineer, New York; the Thomas Fitch Rowland Prize to Shortridge Hardesty and Alfred Hedefine, consulting engineers, New York; the James Laurie Prize to W. W. Pagon, consulting engineer, Baltimore; the Arthur M. Wellington Prize to William J. Wilgus, Ascutney, Vt.; the Collingwood Prize for Juniors to John F. Curtin, The Texas Co., New York; the Rudolph Hering Medal to Robert T. Regester, consulting engineer, Baltimore; the Construction Engineering Prize to Rear Admiral Frederic R. Harris (Retired), consulting engineer, New York; and the Daniel W. Mead Prize to Alfred C. Ingersoll.

General Somervell was not present, it being learned later that he was in Africa at the historic Casablanca conference.

New officers

Ezra B. Whitman, consulting engineer, Baltimore, was elected president to succeed E. B. Black. New vice presidents are E. M. Hastings, chief engineer, R. F. & P.R.R., Richmond, Va., and Thomas R. Agg, dean of engineering, Iowa State College, Ames, Iowa. New directors are Rear Admiral R. E. Bakenhus (Retired), consulting engineer, New York; Prof. C. B. Breed, head of the department of civil and sanitary engineering, M.I.T., Cambridge, Mass., N. W. Dougherty, dean of engineering, University of Tennessee; Dean G. Edwards, consulting engineer, Borough of Manhattan, New York City; C. F. Goodrich, chief engineer, American Bridge Co., Pittsburgh, and Fred C. Scobey, hydraulic engineer, Berkeley, Calif.

A packed auditorium on Wednesday afternoon listened to descriptions and saw pictures of the Alcan Highway. Principal speakers were Maj. Gen. Thomas M. Robins, Acting Chief of Engineers, Brig. Gen. C. L. Sturdevant, Assistant Chief of Engineers, Thomas H. MacDonald, Commissioner of Public Roads, Col. Albert L. Lane, Corps of Engineers, and A. C. Clark, assistant construction engineer, Public Roads Administration.

New refuse-disposal problems

Refuse that goes to incinerators at army camps, according to Jean L. Vincenz of the repairs and utilities branch of the office of the Chief of Engineers, is much drier than generally received at municipal incinerators. This, Mr. Vincenz told the Sanitary Engineering Division, is presenting some real problems in incinerator operation, maintenance and repair. In fact, where army incinerators are designed to handle material having characteristics of 65 percent wet to 35 percent dry, by weight, the present characteristics are nearly 20-25 percent wet, to 75-80 percent dry, by weight.

What is being done by the army using the landfill method of disposal was outlined by Mr. Vincenz. Complete details of this procedure were described in *Engineering News-Record*, Dec. 17, 1942, p. 851.

Performance of final settling tanks of novel design at the 40-mgd. Bowery Bay activated sludge plant in New York City was described by Richard H. Gould, director, division of engineering, department of public works.

Believed to be different from any other final tank hitherto used in activated-sludge practice, these units have sludge scrapers that move the sludge toward a

(*Continued on p. 32*)

Society membership gains during 1942

George T. Seabury, secretary, reported at the opening session of the Am. Soc. C. E. meeting that the society had made a net gain of 916 in membership during the year—the largest in the society's history—bringing the total to 18,354. The largest gain was in junior members. Financially, according to the report of Charles E. Trout, treasurer, the society is in an unusually good condition despite the fact that many members in the military service have been exempted from payment of dues. All enlisted men are automatically exempted, and all officers with base pay below $2,400 are exempted on application.

New board of direction of the American Society of Civil Engineers

A new board of direction took over direction of the affairs of the American Society of Civil Engineers at the annual meeting in New York.

From left to right above, the board members are: John W. Cunningham, Portland, Ore.; F. H. Fowler, San Francisco; Thos. E. Stanton, Sacramento; Charles F. Goodrich, Pittsburgh; Charles B. Breed, Cambridge; Scott B. Lilley, Swarthmore; Fred C. Scobey, Berkeley; Dean G. Edwards, New York; R. E. Bakenhus, New York; G. B. Massey, Chicago; Wm. N. Carey, St. Paul; Thos. R. Agg, Ames; E. B. Black, Kansas City; Ralph B. Wiley, West Lafayette, Ind.; N. W. Dougherty, Knoxville; V. T. Boughton, New York; E. M. Hastings, Richmond; Miss Crook of the headquarters staff; George T. Seabury, secretary; Ezra B. Whitman, president, Baltimore; W. D. Dickinson, Little Rock; J. T. L. McNew, College Station, Texas; Chas. M. Spofford, Boston; George W. Burpee, New York; A. M. Rawn, Los Angeles.

Absent are John W. Cowper, Buffalo; Ernest E. Howard, Kansas City; Gustav J. Requardt, Baltimore, and Charles E. Trout.

Am. Soc. C. E. holds 90th annual meet in New York

(*Continued from p. 31*)

sump located at the effluent end of the tank; conventional practice always has provided for sludge removal counter to flow. The fallacy of conventional practice, which provides that the scraper mechanism move sludge back to the effluent end, is that the scraper is working against the natural flow of sludge, said Mr. Gould.

He pointed out that activated sludge acts differently than primary tank sludge in that it has a tendency to flow over the tank bottom and form a fairly level sludge blanket. This sludge mixture creates a current along the bottom of the tank away from the influent end. On reaching the end of the tank it is forced upward by the end wall and reverses its direction of flow along the top of the tank. In the course of this long flow the tank solids separate from liquid, and the clearest liquid is to be found at the *influent* end of the tank.

Results of operation have vindicated these radical departures from practice, said Mr. Gould. Suspended solid tests disclose that the liquid in the upper three-quarters of the tank is clear, containing only about 10 ppm. of solids. Most of the solids are contained in the bottom foot or two of the tank where the flow was found to be traveling at a velocity that would carry the solids out of the tank in about 15 minutes.

A. L. Genter, consulting engineer of Baltimore, outlined a mathematical method of correlating coagulant requirement in sludge conditioning with a measurement of certain sludge characteristics. The application of this method in plant operation was discussed by Paul D. McNamee, chief chemist, District of Columbia sewage treatment plant.

A symposium on the practice and economy of sludge concentration gave opportunity for plant operators, consultants and research workers to exchange ideas on some highly controversial phases of this type of processing. Participating in the discussion were: R. F. Goudey, sanitary engineer, bureau of waterworks and supply, Los Angeles; C. E. Keefer, associate engineer, bureau of sewers, Baltimore; Willem Rudolfs, chief, department of water and sewage research, New Jersey Agricultural Experiment Station; Wellington Donaldson, director, bureau of sewage disposal, department of public works, New York; Robert T. Regester, consulting engineer, Baltimore, and E. T. Killam, hydraulic and sanitary engineer, New York.

A comprehensive resume of water supply developments in the years 1941–42 was presented by Thomas H. Wiggin, consulting engineer of New York.

(*Continued on p. 33*)

Soil classification for airfields reported to Am. Soc. C. E. meeting

New classification believed to be an improvement on PRA classification. Airfield drainage and soil sampling also discussed.

Two phases of airfield design were considered at the morning session of the A.S.C.E. Soil Mechanics and Foundation Division, Arthur Casagrande of Harvard University reporting upon a special method of soil classification he has developed at the request of the Corps of Engineers, and Gail A. Hathaway, principal hydraulic engineer in the office of the Chief of Engineers, describing the hydraulic criteria being used in the design of drainage systems.

Soils for airfield work

Professor Casagrande's soil classification represents an attempt to list and describe soils according to their usefulness for runway subgrades and base courses. It was deemed necessary because the presently accepted soil classification, A-1, A-2, . . . A-8, was developed by the Public Roads Administration with dirt road wearing surfaces in mind and not bearing capacity, which is the prime criterion for subgrade and bases. For example, it is an A-3 and not an A-1 soil in the PRA listing that should stand first in an airfield runway listing. A comparison of Prof. Casagrande's soil classification with that of the PRA is shown in the chart below.

In discussion, Prof. Karl Terzaghi, Harvard University, reviewed how the PRA soil classification was originated in the late 1920's to bring order out of the chaos of dozens of then-current classifications and also to achieve a practical field classification in place of refined classifications originating wholly in the laboratories. The PRA classification has served its purpose well, but it does not meet requirements for runway bases. He praised the Casagrande classification but suggested that it be supplemented by instructions as to test procedure.

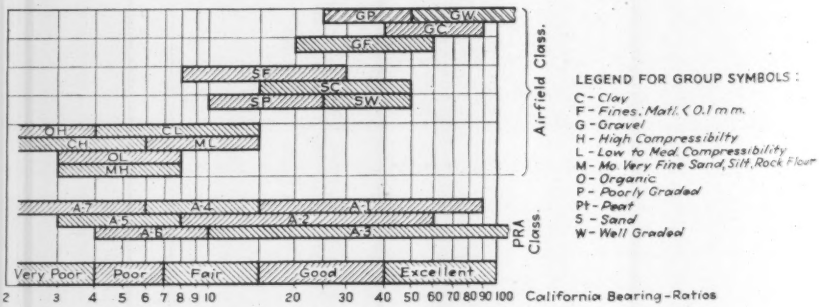
C. A. Hogentogler of PRA, who with Dr. Terzaghi developed the PRA classification, reviewed its successful use in the field of highway design and construction. Mr. Hogentogler in the course of his remarks paid high tribute to O. J. Porter who originated the California bearing-ratio procedure and characterized its application to wheel load curves as the greatest single development in the soil mechanics field.

Further discussion by Col. James A. Stratton, chief, engineering branch, Construction Division, Office of the Chief of Engineers, emphasized the usefulness of the Casagrande classification to the "rule-of-thumb" design and stage-construction procedures necessary on airfields in theatres of war. He reported that the majority of all district and division engineers favor the classification and that it has been adopted as standard for the Corps of Engineers. He pointed out how the correlation of the Casagrande soil classification method with the bearing values of subgrade and base courses is bound to be helpful in applying the rule-of-thumb methods of design required.

A final discussion by Bernard E. Gray, chief engineer, the Asphalt Institute, called attention to the fact that too many A-3 soils have been altered by the addition of clay, which might be proper to obtain a good surface material but is distinctly harmful in a base material in that it interfered with its drainage characteristics. For soils having an excess of fines, Mr. Gray suggested the addition of oil, asphalt or tar to increase its bearing value.

Airfield design

In his paper on design of airfield drainage facilities, Mr. Hathaway presented the various graphs and tables that have been developed to shorten and standardize the design work. Mr. Hath-



Comparison of Casagrande's airfield soil classification with the PRA classification on the basis of California bearing-ratio values. The Casagrande classification uses combination of letters that describe type, grading and compressibility of the soils.

away touched briefly on the types of drainage structures that have been built on the basis of this design procedure, but more detailed discussion was contributed by Capt. G. H. Mittendorf of the South Atlantic Division, in which over 175 airfields have been built in the past two years. Captain Mittendorf called attention to the fact that design specifications set transverse runway grades at 1 percent minimum. Field experience has shown this to be satisfactory and has likewise demonstrated that flatter slopes do not permit runoff without the formation of "duck" ponds. Where groundwater is high, open ditches parallel to and 200 ft. distant from the center line of the runway have proved very efficient.

Soil samples and bearing tests

One of the important activities of the Soil Mechanics and Foundation Division has been sponsorship of an investigation of soil sampling devices, and M. Juul Hvorslev of Harvard University, who has been in charge of it for a special committee, reported on the results to date. It has been concluded that the piston type sampler with "stationary" piston, that is, one in which the piston may be clamped in position on top of the sample while the tube is being driven around it, is most efficient. It eliminates shavings and scrapings, and it does not compress the sample or otherwise disturb it. A report of the studies that led to this conclusion will be published by the committee in the near future.

In discussion, H. A. Mohr of the Raymond Concrete Pile Co. suggested that "undistorted" would be a better term to describe good samples than the usually used "undisturbed." He cautioned against trying to sample soils that cannot be sampled, such as glacial till and hardpan. Samples are expensive, perhaps $6 a foot, and the owner has a right to expect something useful to his project if he spends that much. A. E. Cummings, also of the Raymond Concrete Pile Co., concurred in recommending the stationary piston sampler, and suggested that the wide range of soils in which it is effective can perhaps be increased by providing tubes of different thicknesses and different clearances. He also called attention to the expensiveness of sampling and recommended that preliminary exploratory borings should always be taken before embarking on any large scale program to secure undistorted samples.

Another committee study begun last spring, financed, as was the sampling investigation, by the Engineering Foundation, relates to soil bearing values. Prof. Phillip C. Rutledge of Purdue University, chairman, pointed out that particular attention is to be given to soil bearing as it relates to airfield design. He suggested a more extensive use of photographic records of the samples. The Corps of Engineers is carrying out large scale tests and it is the committee's plan to attempt to correlate this work with small scale laboratory tests.

Several discussions of the subject of soil bearing capacity brought out numerous points of interest. In a written discussion, O. J. Porter, senior physical testing engineer, California Division of Highways, and the originator of the useful California bearing-ratio test, pointed out that while rapidly moving wheel loads do not remain on a given spot long enough to cause maximum deformation, many repetitions may damage the surface even though there is a small deflection each time. Experience has shown that plastic soils may be remolded under such repetitive loads. Also that saturated sands may become "quick" under vibration, although they will take large static loads. Mr. Porter emphasized that elastic deformation does no damage to a pavement, but that it is plastic deformation that is particularly destructive. Soils which consolidate also cause damage, but the deformation, of course, becomes less as the consolidation increases. Thomas E. Stanton, materials and research engineer of the California Division of Highways, who presented Mr. Porter's discussion, remarked on the extensive use to which the bearing ratio test has been put in California.

E. B. Whitman, A.S.C.E. president

George L. Freeman, consulting engineer, New York, cautioned against expecting uniformity in soil sampling studies for a long time to come. For this reason, engineers should be on their guard against accepting results obtained with new and revolutionary samplers.

Lazarus White, consulting engineer, New York, brought up the difficulty and danger of storing soil samples. Not only do they occupy a great deal of space, but it is quite probable that storage so alters them that any studies which might be made with old samples would be useless.

Am. Soc. C. E. holds 90th annual meet in New York

(*Continued from p. 32*)

Dissatisfaction with the present set-up in the Bureau of Governmental Requirements, the agency in charge of sewage works priorities and materials in the War Production Board, was voiced in a resolution initiated by the sanitary engineering section and later adopted by the board of direction of the society. The resolution calls for an adequate and competent staff to be established in the bureau, or in some other section of the War Production Board, to handle matters pertaining to sewage disposal facilities.

Soil-aggregate mixtures

Present trends in the use of soil-aggregate mixtures for roads and runways were outlined to the Highway Division by Roy W. Crum, director of the Highway Research Board. Mr. Crum called attention to the recently advanced hypothesis that cohesion in soils is dependent on films of moisture surrounding the smaller particles (see p. 146 of this issue) and noted that this is in harmony with experience as to the need for checking the loss of moisture from stabilized soils in roads.

The latter part of the Highway Division meeting was given over to a discussion of a paper on trends and problems in highway engineering education by Gibb Gilchrist, dean of engineering at Texas A. & M., which was read by Prof. J. T. L. McNew of Texas A. & M. Dean Gilchrist devoted much of his paper to the broader question of engineering education, outlining an educational program that the college had started to put into effect before war was declared. It includes a postgraduate training program of extension study under which graduates would return periodically for examination and advanced degrees.

New trend in housing

A definite trend away from permanent housing for war workers was reported to the City Planning Division meeting by Jacob L. Crane, Jr., director of urban studies for the National Housing Agency. In the earlier stages of the war housing program, Mr. Crane said, it seemed clear that government war housing, when built in localities where it could be used after the war, would be most economical if designed to permit its occupancy for 20 years or more. Accordingly, in most of the built-up areas of defense production, some permanent government war housing was built. Similarly, for the localities where the government war housing would not be needed after the war, it seemed clearly economical to provide demountable housing which could be moved after the

(*Continued on p. 34*)

war for use elsewhere. Now, the urgent need for the economical use of materials has forced the government war housing program almost wholly into the provision of temporary dormitories, temporary dormitory apartments for couples, and temporary family dwelling units. All three categories are reduced to minimum floor areas, minimum use of metals for utilities and equipment, and (at least during most of 1942) minimum use of soft-wood lumber.

Postwar housing was the subject of a paper by Harland Batholomew, city planner of St. Louis, Mo. He estimates that to meet housing requirements in the 10-yr. period following the war, construction of 828,000 non-farm dwelling units yearly will be required. This total would include 140,000 units to accommodate new population growth in cities; 336,000 units to replace obsolete units now 50 years or more of age; and 352,000 units becoming obsolete each year.

If citizen's groups do not work hard and effectively, 95 percent of all post-war housing in American cities will be built in remote suburban areas, Mr. Bartholomew believes.

Ships on production lines

A. J. Ackerman, director of engineering and plant expansion of Dravo Corp., Pittsburgh, told the Construction Division of shipyards built by his firm for ship construction by assembly line methods. Emphasizing need for space in the yards for precutting and preassembly, he showed how production at an existing yard had been increased by assembly away from the ways. Hulls have been fabricated at Pittsburgh and assembled into maximum sections that can be transported and shipped by rail to yards on the Atlantic seaboard for assembly.

Side-launching ways, used for barge construction for years, have been adapted to sea-going vessels. Crews work in one position and the ships move by on a level keel until reaching launching ways at the end of the assembly line. Work scaffolds are fastened to the hull and move with it to completion of the vessel.

Dravo has been building barges of welded construction since 1936 and has used welding extensively for other work for some years. Mr. Ackerman stated that a great need of shipbuilding at present is redesign of the ships to take full advantages of the new welding and preassembly techniques that are available.

Concrete durability studies

Charles Wuerpel, senior engineer, North Atlantic Division, Corps of Engineers, U. S. Army, outlined to the Construction Division durability studies of cement and concrete specimens under different conditions. Samples used are 6-in. square and 4-ft. long and are cast in vertical position to simulate columns. Accelerated natural conditions for tests are found at the Bay of Fundy at Eastport, Me., where samples are exposed to rapid cycles; high tides cover and thaw the specimens, which are again exposed and frozen at low tide. Similar samples have been placed at a point in the Cape Cod Canal and in warm Florida waters. Comparisons indicate that deterioration is probably caused almost entirely by repeated freezing and thawing rather than by chemical action, as little deterioration is apparent in the Florida samples.

A. J. Boase of the Portland Cement Association, discussed recent developments in reinforced concrete structures before the Structural Division. Specifically mentioned were wider flat slab spans, dome construction, beehive igloos, rigid frames of 85 ft. span with prestressed ties, concrete girders for craneways, a continuous concrete girder bridge of 75-105-75 ft. spans, the Morganza floodway railroad bridge, buttressed water tanks using structural block between the ribs and tanks with steel prestressed to 22,500 psi.

In discussing developments in concrete, Prof. Geo. A. Maney of Northwestern University suggested omitting the figure "n" from the formula for compression steel in beams and girders as it is already omitted from column formula.

According to Prof. Howard Hansen of Texas A. & M., wood is replacing 25 items on critical material lists. He gave a new formula for determination of weight of wood trusses and stated that a move is under way to increase the working stresses in timber.

Fireproofing of timber has made great advances in the past year. According to Mr. Hansen, brush coats of fireproofing are not safeguards at high temperatures but pressure impregnated timbers are very resistant to any fire.

In discussion, Verne Ketchum, chief engineer of Timber Structures, Inc. of Portland, Ore., stated that the bowstring arch is 10-12 percent cheaper than other timber trusses due to the shape being adaptive to placing the maximum stresses in the main members and low stresses in the web.

Commenting on fireproofing, Mr. Ketchum said that the processes used do not injure the lumber. The fireproofing impregnation may increase the moisture to a total of 83 percent, but subsequent drying to 30 percent moisture does not cause checking or loss of strength. Below 30 percent moisture checks occur but strength actually increases as moisture decreases down to about 12 percent moisture. Below this there is no increase in strength.

Ralph Mann, field engineer of the Wood Preservers' Association, New York, spoke of the present situation as a renaissance of wood construction with wood displacing the materials that have been substituted for it.

Press Assn. Photo

Libya desert railway rebuilt

Just before the great offensive of the British 8th Army in North Africa was launched, the railway running from Mersa Matruh to a point a few miles from Tobruk had been used by the enemy. The railway was damaged heavily by Allied bombing attacks, and then the enemy destroyed parts of the line during the retreat. Above, Indian troops of the 8th Army, under direction of a South African railway repair company, are clearing away debris of a bombed and wrecked enemy ammunition train, preparatory to rebuilding the road. In addition to the actual repair work, almost every inch of track had to be probed for hidden mines and "booby" traps before rail traffic could be resumed.

OBITUARY

Arthur J. Griffin, 65, chief engineer of the Bureau of Highways and Sewers for the Borough of Brooklyn (N.Y.), died Jan. 20. Connected with the department for 47 years, Mr. Griffin directed many important extensions of the borough's sewer system, made necessary by increases in population.

Ed L. Harrington, 47, chief construction engineer of the Blaw-Knox Steel, Co., Pittsburgh, Pa., died at Canton, O., recently.

Nathaniel A. Richards, 59, president of Purdy & Henderson Associates, Inc., consulting engineers of New York City, died at Maplewood, N. J., Jan. 19. Mr. Richards was one of the organizers of the company in 1934, and had been its president since organization. He was an authority on foundations and wind-bracing on skyscrapers.

Arthur C. Coughlan, 48, treasurer of the Coughland Construction Co. of Boston, Mass., died Jan. 18. Cited for combat service in command of the 14th engineers during the last war, he supervised rehabilitation of French villages before returning to this country. He was active in his firm's construction of the Ware River tunnel of the Boston Water Supply, and many other projects.

Robert Lee Whitehead, 52, of Elkin, N. C., resident engineer for the North Carolina Highway and Public Works Commission, died recently at Elkin.

F. O. Condon, 64, of Moncton, N. B., who retired recently as chief engineer for the Atlantic region of the Canadian National Railways, died recently at Moncton. An employee of the railroad's engineer department since 1905, he had been forced to retire because of ill health.

William A. Sickler, 87, treasurer of the Buffalo (N.Y.) Corrugated Container Co., and a pioneer irrigation engineer of the West, died recently at Buffalo. Mr. Sickler went West in 1878 as a government land surveyor, later becoming consulting engineer on the Shoshone Dam Project, and holding other posts in charge of irrigation projects in Wyoming, Montana and California.

Edward Ginley, 82, one of the pioneering building contractors of San Francisco, Cal., who played a part in building the Richmond-Parl-Presidio districts, died recently.

J. T. Brown, 93, pioneer Atlanta, Ga., building contractor, died recently.

Railroad around Shasta Dam now S. P. property

The 30 mi. of new railroad over which the main line of the Southern Pacific is detoured around that part of its former route that will be submerged by Shasta reservoir waters and which was built at the expense of the United States Government, recently was transferred to the railroad company. Although the Southern Pacific began a gradual changeover of operations from the old line to the new many months ago, it was not until late in December that the actual transfer of the line was completed. The deed conveying ownership of the properties from the government to the Southern Pacific was recorded Dec. 28, 1942.

The new line has eight steel bridges with a combined length of about 2¼ mi. and twelve tunnels totaling more than 3½ mi. in length. The Pit River Bridge exceeding half a mile in length and 500 ft. in height, one of the tallest railroad bridges ever built, carries the railroad on a lower deck and the Pacific Highway, a main coastwise route, on the upper deck.

Under the terms of an agreement made between the government and the railroad in 1940, the 12.86-mi. portion of the old line from Redding to Coram just below Shasta Dam is being maintained by the government. The Southern Pacific is permitted to use this spur for a fee of 10 cents per thousand gross ton miles for all equipment operated and freight transported by the company in serving the Shasta Dam project and the Mountain Copper Co. at Matheson. Under the agreement the government also has operating rights on this spur.

In The Last fiscal biennium, the Minnesota state highway department has completed building of 51 new bridges, 13 railroad over or under passes and five highway grade separations.

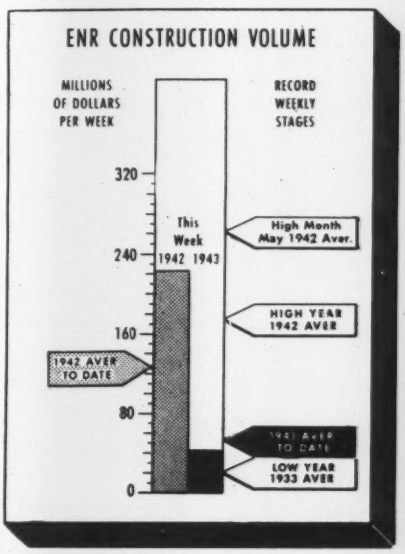
CONTRACTS AND CAPITAL

Engineering construction volume for the week totals $41,855,000, a decrease of 38 percent from the preceding week, and 81 percent below the corresponding 1942 week. Private construction tops last week by 15 percent, but is 77 percent lower than last year. Public work is 41 and 82 percent lower, respectively, than a week ago and a year ago, as both state and municipal work and federal construction declined.

The current week's total brings 1943 construction to $226,826,000, an average of $56,707,000 for each of the four weeks. On the weekly average basis, the 1943 volume is 55 percent below that for the five-week period last year. Private work is 62 percent lower, and public is down 54 percent when adjusted for the difference in the number of weeks reported.

In the classified construction groups, gains over last week are in waterworks, industrial buildings, and earthwork and drainage. All classes of work declined from their respective totals of a year ago.

New capital for construction purposes for the week totals $1,432,000, made up entirely of state and municipal bond sales. New financing for the year to date amounts to $4,498,000 for the four-week period, a volume that compares with $559,914,000 reported for the opening five weeks of 1942.



CONTRACTS

(Thousands of dollars)

	Week Ending Jan. 29 1942	Jan. 21 1943	Jan. 28 1943
Federal	$187,231	$61,007	$36,488
State & Municipal	17,307	3,426	1,349
Total public..	$204,538	$64,433	$37,837
Total private.	17,156	3,497	4,018
TOTALS	$221,694	$67,930	$41,855
Cumulative 1943 (4 weeks)			$226,826
1942 (5 weeks)			$628,780

Note: Minimum size projects included are: Waterworks and waterways projects, $15,000; other public works, $25,000; industrial buildings, $40,000; other buildings, $150,000.

NEW PRODUCTIVE CAPITAL

	Cumulative 1942 5 weeks	1943 4 weeks
NON-FEDERAL	$109,914	$4,498
Corp. Securities.	24,565	.....
State & Mun....	74,049	2,998
R.F.C. loans....	11,300	1,500
FEDERAL	$450,000	.....
TOTAL CAPITAL.	$559,914	$4,498

ENR INDEX NUMBERS

Index Base = 100		1913	1926
Construction Cost	Jan. '43	283.45	136.25
Building Cost	Jan. '43	226.87	122.64
Volume	Dec. '42	227	100

FHA MORTGAGES

	Week Ending Jan. 24 1942	Jan. 16 1943	Jan. 23 1943
Selected for appraisal			
Title II....	$13,360	$3,377	$3,314*
Title VI...	$10,821	$8,320	$9,838*

* Subject to revision.

EDITORIALS

VOLUME 130 NUMBER 4

January 28, 1943

Sanitary Engineers in the War

SANITARY ENGINEERING occupies an exceedingly important position in the war effort, both at home and abroad. Always a challenge, the maintenance of public health through control of environmental conditions in wartime determines how well soldiers can wage battles and how much civilians can produce. The record to date is one of great accomplishment. Army camps have been singularly free of epidemics, and troops in the field have had the safeguards afforded by latest developments in sanitary science. At home the record likewise has been impressive. Millions of people have migrated to war centers, many of these without adequate community facilities; that serious epidemics have not occurred is high tribute to the skill of the local, state and federal health authorities. An official acknowledgment of the need and importance of sanitary engineers was made last week when War Manpower Commissioner McNutt announced that such men soon would be allocated as were doctors. Never before has the work of the sanitary engineer received greater public attention, and he can look to the postwar period as one that will create even greater demand for his services.

Shipyard Design Improves

HIGH-LEVEL OUTFITTING docks in a shipyard for Liberty freighters is one of the latest innovations thought up to speed ship production. The shipbuilding industry has been transformed by the extensive adoption of prefabrication, and this transformation, in effect, opens up a new construction field in which it is only natural that innovations should appear; they are part of the development process. For example, at first it was not realized how very much space is needed to take full advantage of the prefabrication idea. Many of the yards that were built a year or more ago have since added more space, some even providing sub-assembly or prefabrication shops. Now, at Marinship, a new yard that was laid out with benefit of previous experience in the need for ample working and storage areas, another significant change is made—the introduction of deck-level outfitting docks. Such docks permit elimination of heavy and slow high-lift gantry cranes and the substitution therefor of light truck cranes; and they put the working platform at the level of the work. A new industry is finding its stride, benefiting greatly by viewpoints unhampered by precedents, the viewpoints of men from the field of engineering construction.

Flight Strip Development

MILITARY SECRECY enshrouds many of the interesting facts relative to the current flight strip program, but enough is known to give some indications of their possible importance in the post-war world. Although those now under construction are primarily for military use, flight strips, as first proposed by Col. Stedman S. Hanks were visualized as aids to civil aviation. They were to be adjacent to transcontinental highways, which would thus serve as route markers for airplanes. They were to be near small towns that had no other airport. And they were to be spaced close enough together to increase the safety of flying by providing for frequent emergency landings. It is to the credit of the Army Air Corps that it has planned its flight strip program to fit into such a pattern as closely as military requirements will permit. Very few of the present flight strips are so located that they will not be usable after the war. The Air Corps has also made other contributions. It has specified that local materials shall be used for construction, and has permitted experiments in construction procedures, both of which will develop data useful in the future. Military operation experience will also give the single-runway field a good test. All in all flight strips will bear watching. Large numbers of them may have to be built.

Changes in Runway Design

NEW KNOWLEDGE was gained during the past year of the place that vibration occupies in the design of airport runways. Before the effect of the vibration of the motors of standing or slowly moving airplanes was recognized, common practice was to put lighter pavements on taxiways, turn-arounds, aprons and standing areas than on runways, the assumption being that runways, in addition to carrying the plane had to withstand its impact on landing. But experience has shown that the simple and infrequent shocks of impact are not nearly so damaging as the repetitive jars of vibrations, which can convert an otherwise stable base material into a plastic material inadequate to support the pavement. As a result, deflection of the pavement may

increase from 20 to 100 percent over that due to dead load alone. To offset this effect, the army now increases the gross wheel design loads on the service areas by 25 percent. And in the design of runways, no allowance is made for impact. Thus, again, theory based on assumptions that appeared sound gives way to knowledge based on practical experience, and engineering is advanced thereby.

Timber Stresses

COMMENT AT THE A. S. C. E. meeting last week indicates that a move is underway to increase permissible stresses in timber, much as has been done for steel and concrete. Because of the current practice of upgrading timber and a tendency to use whatever is available, there are strong reasons why it would be inadvisable to institute any general increase in timber stresses for permanent work. For temporary construction, however, a better case for more liberal working stresses can be made out. If it can be shown that such increases would make the available timber go farther, reduce the metal necessary for fastenings or decrease the amount of timber that has to be transported, they may be worthwhile. After all, working stresses up to 2000 psi for structural grades of pine and fir have been used for years in the design of contractors' temporary plant facilities. War structures of comparable character could justifiably be designed on the same basis.

Pooling Construction Equipment

PLANS FOR POOLING all construction equipment owned by governmental agencies within the borders of any one state are outlined in Pamphlet No. 1 of the Governmental Division, War Production Board (*ENR*,Dec.31,p.892). These plans are an outgrowth of a survey of construction equipment made recently by the WPB to determine what and how many machines are available to meet current needs while the productive capacity of equipment manufacturers is largely tied up in meeting military requirements of one kind or another.

Pooling of this kind is good in theory, but a first essential to its successful operation is that the greatest possible amount of local cooperation be developed within each state. An ideal plan would appear to be one organized by some state agency, such as the state highway department, with Washington acting only as a clearing house for records of the equipment, so that the Governmental Division of the WPB at all times will know where equipment is located and what its service condition is. But even this is only a basis. It must be supplemented by mutual confidence between state, county and city agencies if the plan is to work successfully. Each organization must be prepared to meet requests for the loan of equipment to the maximum of its capacity, and each must accept without question the other's decision as to the amount of equipment it can spare. If either shows lack of faith in the other by appealing to Washington to crack down on the other party, mutual confidence will be destroyed and the plan will largely go by the board.

But the major factor in determining the success or failure of this pooling plan is the attitude taken by those in authority in Washington toward the local groups. If attempts are made arbitrarily to order one local group to turn equipment over to another, if there are threats to "requisition" equipment from one agency to turn it over to another, or if Washington attempts to tell a local agency, on the basis of some theoretical determination made in Washington, that that agency has equipment that it can spare, when the local agency in question holds it has no spare equipment, any value that the plan may otherwise have had will be destroyed. Very broad powers have been vested by Congress in the War Production Board, but there is grave doubt as to whether those powers are broad enough to permit the WPB to commandeer the property of a state, or even to order that state to turn its property over to one of its subdivisions. Attempts to take such drastic action are bound to be detrimental to the proposal.

Equipment for both construction and maintenance already is getting scarce in many parts of the country; conditions will get worse as time goes on. Repair parts are particularly difficult to obtain, and hence much equipment that otherwise could be serving a useful purpose is standing idle. The pooling plan now proposed by the Governmental Division of the War Production Board has large possibilities for helping to correct this condition, if state, county and city public works departments will cooperate in setting up local pooling plans and if the WPB office in Washington will foster the autonomous functioning of the local groups.

ENGINEERING NEWS-RECORD WALDO G. BOWMAN, *Editor* *Copyright 1942, by McGraw-Hill Publishing Company, Inc.*

EDWARD J. CLEARY, *Managing Editor. New York:* V. T. BOUGHTON, A. N. CARTER, H. W. HUNT, E. R. DENMARK, E. E. HALMOS, Jr. *Chicago:* H. W. RICHARDSON. *Washington:* PAUL WOOTON, R. B. COLBORN. *San Francisco:* N. A. BOWERS. *Consulting Editors:* F. E. SCHMITT, W. W. DeBERARD

EDITORIAL OFFICES: 330 WEST FORTY-SECOND STREET, NEW YORK, N. Y.

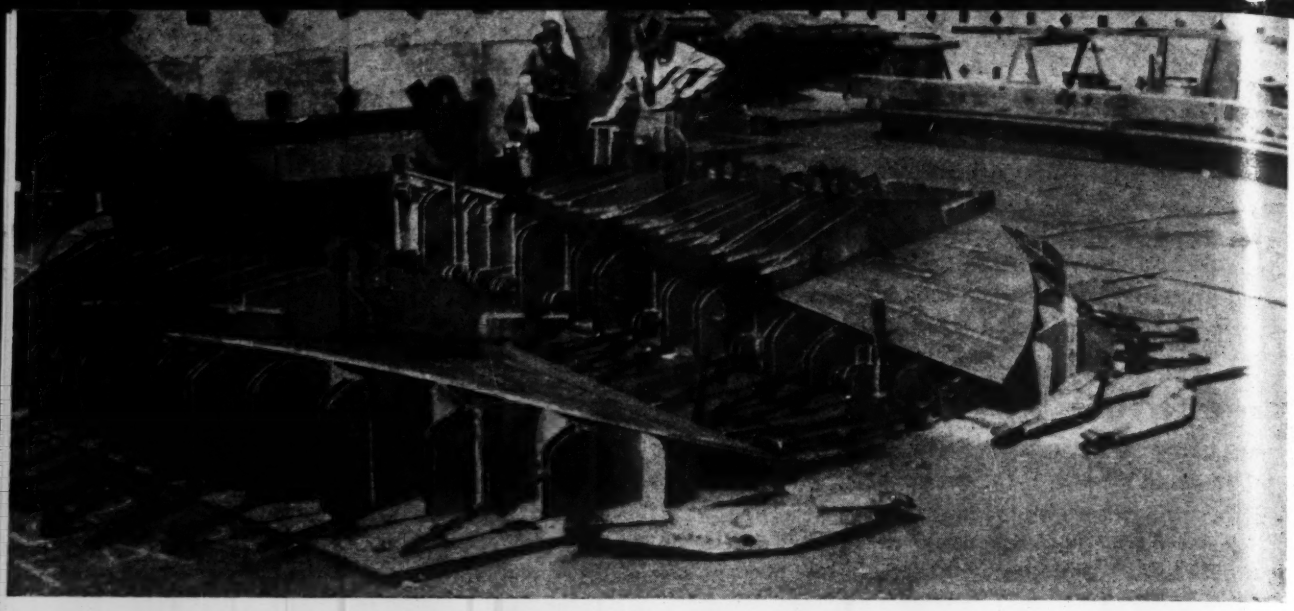


Fig. 1. Special forms on which heavy plates are first warped and then heated to make curvature permanent.

Steel Fabrication Methods at Calship

***Contents in Brief**—A shipyard at Wilmington, Calif., designed and laid out with a primary view to steel fabrication requirements, welds nearly all seams and uses some 20,000,000 lb. of welding rod per annum.. Labor at this yard is listed (and defined) in 480 classifications. Training courses are being given to almost 4,000 enrollees; equipment is kept at high operating efficiency. Production to Jan. 1, is 109 Liberty ships.*

CELEBRATING A YEAR of high-speed ship construction, the California Shipbuilding Corp. of Wilmington, Calif., observed its anniversary on Sept. 27 last by delivering the sixty-seventh ship of the EC-2 class, which is equivalent of putting the yard 202 days ahead of original schedule. This yard holds the record for the largest number of ships delivered in a 12-mo. period although it has only 14 ways as compared to the 16 that some competitors operate. During one month in the fore part of 1942, it turned out 15 ships—one every two days.

This record has been attained despite the fact that Calship is one of the first yards laid out to provide for extensive prefabrication—the advance assembly of principal parts of the ship which are later moved bodily into place. In other words, builders of this yard had to do their own pioneering. The yard went through the usual program of almost doubling designed capacity after construction was already well under way on the original plans. Also, the yard layout, which at first seemed to provide generous prefabrication areas, was later found to need a separate prefabrication shop, and such a building was added to give more room for work on large units. The yard has no overhead utilities. Not only are the water and electrical systems underground, but oxygen and acetylene are piped under pressure to all parts of the yard.

Fig. 2. Assembly skid rails have holes in flanges, paint marks on heads, to speed accurate placement of plates without measurement.

Pioneering in the amount of welding substituted for riveting, this yard uses only 22,000 rivets in the standard EC-2 ship, and nearly all of these are used in attaching the frames to the sides of the shell. There are no rivets in the fore and afterpeaks on which the welding sequence and procedure has been worked out to practically eliminate distortion from welding operations.

Frequent changes have been made in assembly technique as experience has shown new ways to simplify erection of the ship structure or increase the percentage of downhand welding. For example, on the second deck, hatch sections are now pre-assembled on a jig before final welding, and the coaming is welded on with the hatch beams before the section goes to the ship, thus obviating awkward welding and decreasing the work done on shipboard.

Welders total 5,400

With a normal operating force of 36,000 workers in the three shifts, Calship has assigned about 5,400 men to welding operations. The welding crews are served by about 1,800 welding leads with which the average

consumption is about 50,000 lb. of welding rod per day or 20,000,000 lb. per year. Because welding is such an important activity at this yard, it has been given careful study to maintain high efficiency and economy.

One of the means to this end has been the program of keeping a record of each welder's daily performance as measured by the weight of welding rod used. A record is made of the weight of rod issued to each welder at the beginning of each shift and from this figure is deducted what the welder turns in at the end of the shift. This is accomplished by requiring the men to turn in the stub ends of used rods. Stubs shorter than 2 in. are not deductible weights as they are considered "used rod" but even these short stubs must be preserved and turned in at the close of the shift so that (1) there is evidence that the welder has used up the proper length of each rod, and (2) this scrap metal can be easily salvaged. Rod left-overs are re-issued for use if they have a length of 8 in. or more.

The amount of welded joint made manually has averaged, over a seven-day period, as much as 88,000 lin. ft. per 24 hours. In addition, automatic welding accounted for from 10,000 to 14,000 lin. ft. per day. Use of devices for rotating a working part to increase the percentage of downhand welding and other prefabrication expedients have contributed much to increasing the efficiency of welders. After the yard was well under way the efficiency of manual welding, in length of seam per welder per day, increased 60 percent in six months. This is partly ascribed to the greater percentage of downhand work and partly to more space as the welding operations were arranged in more convenient form.

Attention is being given to reclaiming welding rods with damaged coatings of lengths sufficient to warrant re-use. This investigation is directed particularly toward the question of whether a re-dipping process can economically restore the damaged coating.

Some large alternating current welding units recently have been provided for use in the plate shop where there is considerable flat work on short runs. Thus there are gained the advantages of no commutator or lubrication problems; of efficiencies above 90 percent (as compared to 65 percent in d.c.); and of not much

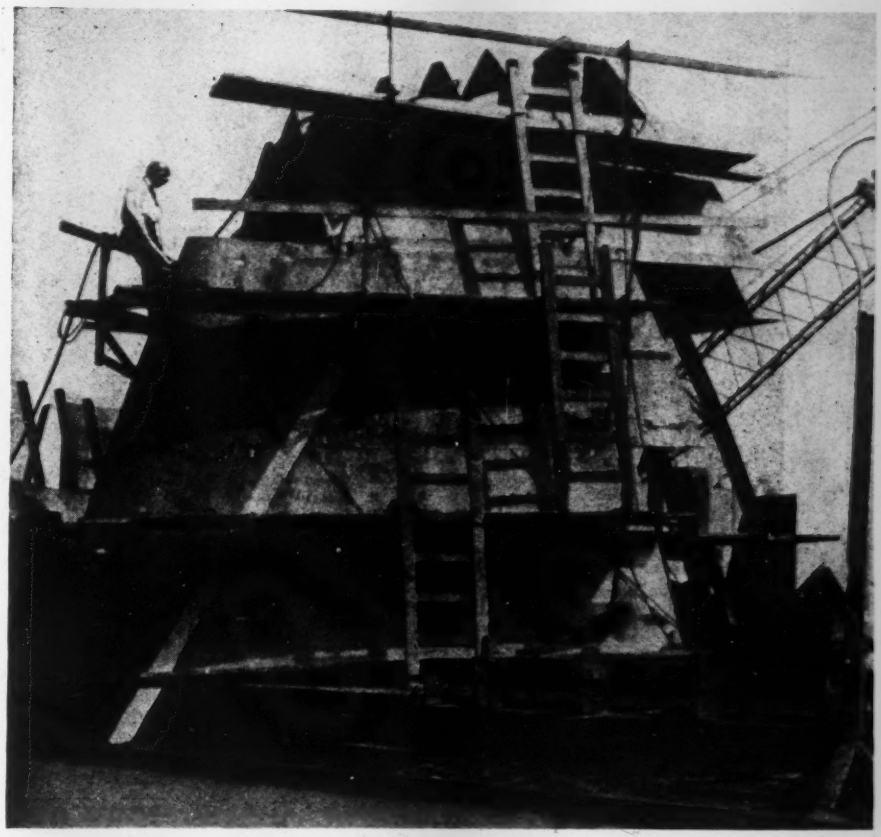


Fig. 3. Forepeaks are assembled entirely by welding in a sequence that avoids warping. This 56-ton section is the heaviest preassembled at Calship. It is lifted to place in the ship by two cranes.

Fig. 4. One of the welding rod supply-and-record stations to which all welders go at start and end of shifts.

Fig. 5. Rocker supports put small steel assemblies into convenient position for downhand welding.

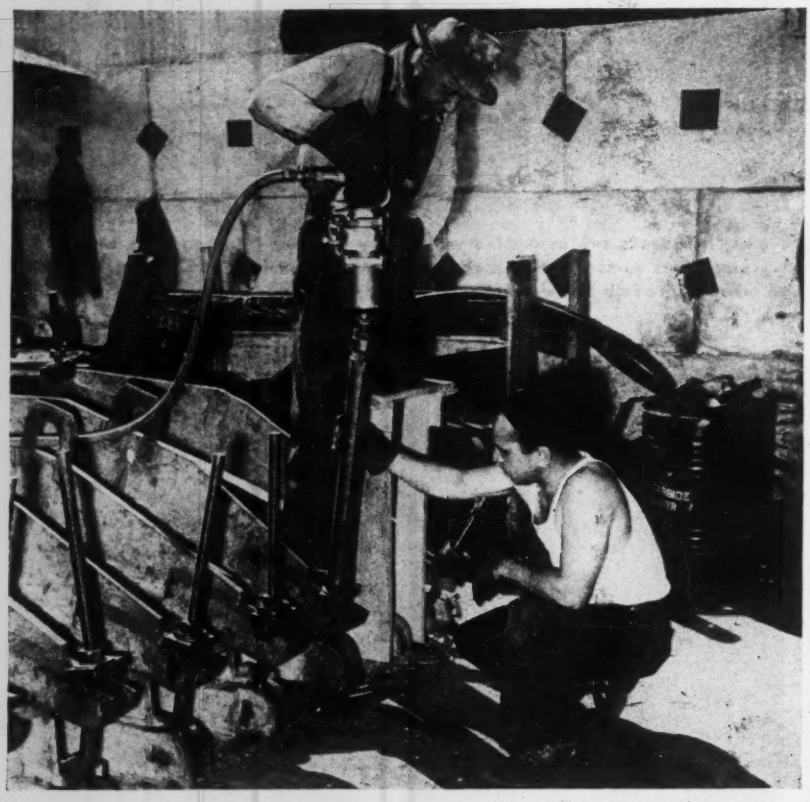


Fig. 6. Air-driven wrenches speed the bolting operation in giving the heavy plates compound bend.

load loss in idling, only about 500 watts as compared to about 3 kw. on the d.c. units. For the most part, the welding machines that are shifted about the job are in double-decker skips of four. There are 84 of these.

At this yard very little welding is "farmed out" to be brought to the yard ready assembled. Masts and stacks are bought on this basis, but very little else. The total amount of welded seam per ship amounts to about 272,000 lin. ft. of which 240,000 is manual welding and 32,000 lin. ft. is done with automatic continuous machines.

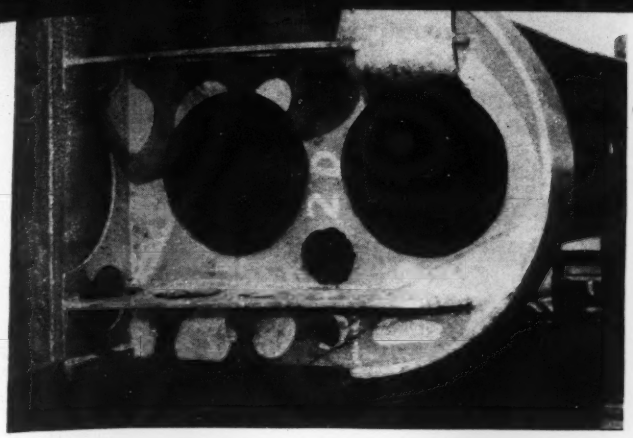
The new prefabrication shop, 400x 380 ft. in plan, which was not added until after a year of operation has proved particularly useful in saving time by giving more space for work on the large assemblies. For example, in this new shop only fixed-in-place jigs will be used. Prior to completion of the new shop these jigs had to be set up for each ship on the skids, the only convenient place for operation, but a location such that removal of the jigs to make space for other operations was necessary after each set-up.

The prefabrication shop has four 75-ft. bays with a clearance of 44½ ft. under the cranes. Thus space is available for handling such assemblies as sections of the side shell, portions of upper deck, parts of afterpeaks and forepeaks, stern castings, etc. At each end of each bay, crane rails are extended over storage areas; at one end this is for material stock piles, and at the other end for fabricated parts. Each bay in this shop works independently, and its schedule provides for a margin in completed parts as assurance against delays when minor breakdowns occur.

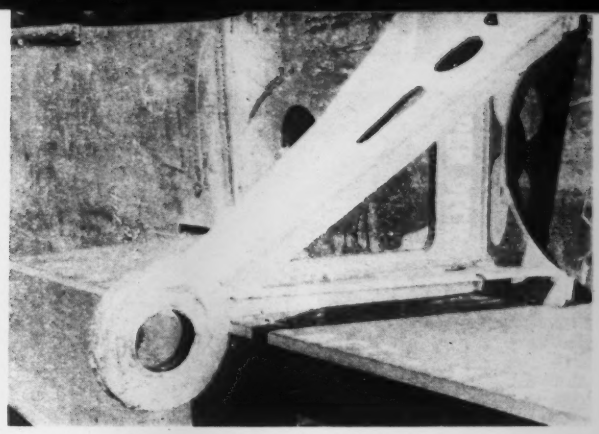
The heaviest lifts, which are made with two cranes, are in placing the forepeak assembly, a piece that weighs 56 tons. In terms of size, the largest sections are the 28x60-ft. portions of the shell sides, lifted with the aid of 60-ft. steel channels bolted along the top and the bottom. In handling these pieces a strongback is used that gives a two-point, vertical lift. The gantry cranes extensively used at this yard have capacity variations, as usual, in inverse proportion to boom radius; the range is from 45 tons at 30 ft. boom to 10 tons at 89 ft., the maximum radius.

On both sides of prow and stern, just above the keel, are a few extra heavy plates that have convex and concave roll in addition to a decided twist. The shaping of these plates has been simplified by the construction of heavy metal dies in which the plates can be bent to the desired shape and held there while heat is applied to relieve the bending stress.

These dies are exact reproductions of the shape in which it is desired to form the plate and are of sufficient weight and strength so that flat plates can be forced down to the desired shape on them without distortion of die. After the flat plate has been laid on the die, a series of strongbacks is put over it and bolts are used to



A heavy type of roller, which is welded in place, to handle the larger pieces that go into construction of the second deck.

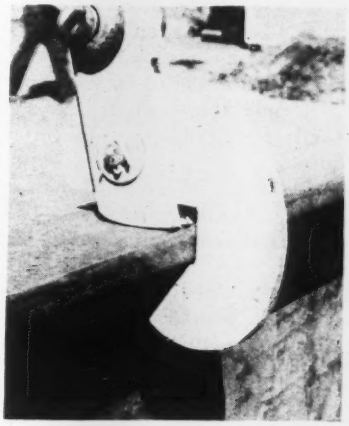


On edge opposite the "roller" are "lifters" to distribute stresses safely as the assembly is raised.

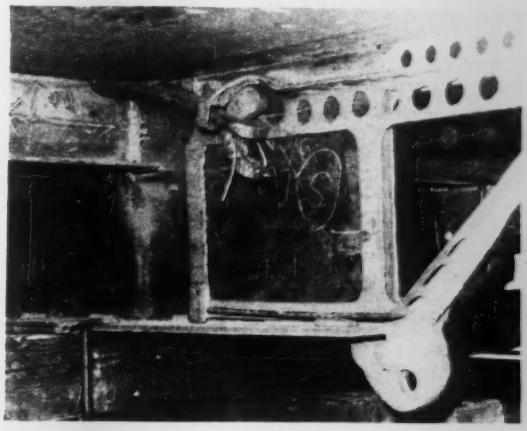
Ingenious Lifting Devices that Speed Prefabrication at Calship Yard

The lifting stress moves a jaw as a safety clamp to prevent this deck-section lifter from letting go.

This type of lifter designed to fit a bulwark rail insures safe operation during movement of the rail.



A specially designed lifter that has an ingenious curved wedge, which is used for locking the adjustable lever arm in place.



Another form of lifter used extensively is this one bolted into place on a heavy shell assembly.

A hatch coaming lifter that was built to fit over and to make use of the standard hatch beam holder.

One of the best lifters to speed construction at Calship is this one which is designed to fit the coaming around the hatch.

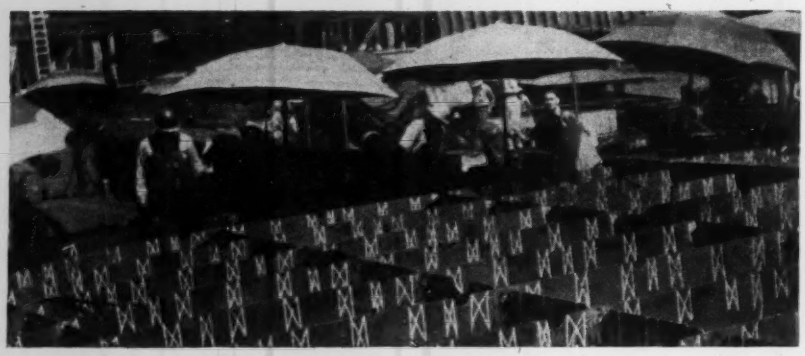
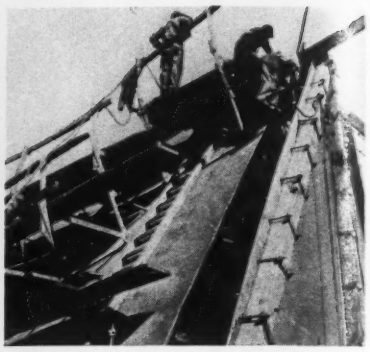


Fig. 7. Beach umbrellas prove convenient and economical for providing shade for welders working outside. Sun and the heat of welding make relief welcome.



Angle-iron brackets, attached to ears welded to the plates, carry staging.

draw together the two parts of the die or form. When the plate has been drawn to shape and is firmly held there, gas torches are used to heat the plate, relieving the stresses set up by bending. Thus when the bolts are removed and the plate is lifted out, the desired shape is retained.

This method is reported to be highly satisfactory, not only in obtaining the proper shape but in reducing to a minimum the time requirement. With the equipment described, shaping and heating operations require a total of only six man-hours per plate.

Classification of workers

Special attention has been given to breaking down the work in the various departments so that each operation will be classified as exactly as possible. On the first anniversary of launching hull No. 1, the yard was using 480 classifications, which is many more than the total number defined in the 1938 dictionary of the U. S. Employment Service. In this classification of labor, the U. S. Employment Service has helped, but in many instances Calship has worked out its own definitions and it is expected that these will be incorporated in the next edition of the U.S.E.S. dictionary.

For each of the 480 classifications not only has a definition been written and adopted, but the file record is provided with a photograph of the machine or tool in operation. This picture has a descriptive caption and a full-page form listing duties of the job, experience and education required, as well as all other requirements in special knowledges or skills, physical and personal qualifications and references. Where feasible, the machine description includes the name of maker, model, speed, and a listing of any attachments used. This record states whether the worker sets up, repairs, operates, or tests the machine and indicates the accuracy range required.

What the worker must have or furnish in the line of tools, licenses, special clothing or other equipment is indicated, and what special equipment is required of the employer is also noted. An essential feature of this record is the number of the union local to which the operator must belong before he can be employed. All hiring at this yard is done through union hiring halls.

Pioneer work in the yard layout, with special provision for prefabrication of parts, was done in designing rooms of the Bechtel-McCone-Parsons Corp. Construction involved a record-speed job in driving 60,000 piles.

Calship gives special attention to training men for lines of work in which replacements and additional man-power are needed. Many employees study to equip themselves for better jobs. A recapitulation for the month of September shows a total enrollment of 3,918 in courses covering eight different shipyard occupations. Welding, naturally the most popular course, had a total enrollment of 1,556, and 37,488 hours of instruction were given. During the month 426 welders were certified by the school to the production department.

Somewhat similarly, equipment is continually being inspected and conditioned for high class performance. The amount of "down time" on all important equipment items is carefully recorded and compared with repairs. The purpose of this is to train operators to anticipate mechanical needs. Repairs that are made in time greatly decrease the man-hour loss that has to be added to repair costs when an actual breakdown occurs.

The result of this policy is low outage time on much important equipment. A few examples, from recent monthly reports, are given in the accompanying table. This kind of record is not achieved without attention to warning signs of wear or weakness. From the monthly reports are such repair items as these.

Cutting tips cleaned	25,327
Burning torches repaired	575
Tips machined and reseated	2,261
Oxyacetylene hose repaired	199,130 ft.
Oxyacetylene hose sent to salvage	2,275 ft.
Pneumatic hose repaired	306,657 ft.
Welders hoods repaired	1,112

And in the monthly repair list are two items that serve as eloquent reminders of what could happen if safety rules were relaxed. These are: goggles repaired, 6,434; hard hats repaired, 266.

TYPICAL OPERATING RECORDS FOR CALSHIP IN SEPTEMBER, 1942

Department	Theoretical hours	Hours lost by breakdown	Percentage of Time operating
Plate shop	34,560	690	98
Sheet metal shop	10,800	32	99.7
Pipe shop	10,080	103	98.9
Pipe & copper shop	10,080	50	99.5
Machine shop	36,000	359	99
Compressor house #1	3,600	18	99.5
Compressor house #2	720	72	90
Acetylene plant	720	...	100
Oxygen plant	720	...	100
Revolving cranes	22,320	230	98.97
Truck cranes and other rolling stock	31,248	832	97.34
Bridge crane	11,904	141	98.81

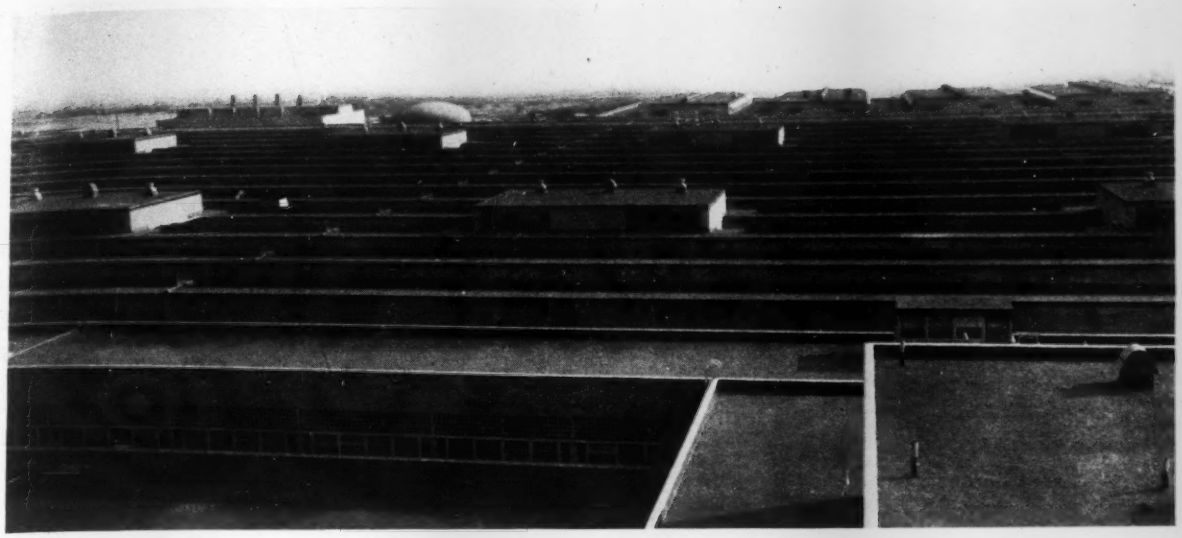


Fig. 1. Roof view of factory illustrates how penthouses are located between monitors.

Designing Efficiency into a War Plant

***Contents in Brief**—Steel framed factory conserves steel by attention to economy in design. Cantilever trusses support penthouses, while members in penthouse framing serve as hangers to aid in support of beams at right angles to trusses. Bays are 40x80 ft. Walls are combination of masonry, sash and glass block, and monitors are enclosed in glass block. In a new addition, cement-abestos sheets replace glass block for blackout improvement.*

AMONG THE HUNDREDS of war plants, which each of the past three years has seen completed, there are a few that stand out above the rest as justifying the potentialities of modern industrial building design. One of the top candidates for this high position in 1942 was the Nassau plant of the Sperry Gyroscope Co. In contrast to the average industrial plant whose interest to engineers and architects usually resides in a single feature such as layout, appearance, unusual framing, novel wall details or deft handling of utility installations, this plant has some claim for distinction in all of these particulars.

Consisting of two units, an original factory and an extension almost as large, the plant covers a good many acres. Although both of these units are identical in layout, the last one to be built affords a striking example of how substitutes can replace more critical items.

A structural steel frame is used throughout, but the brick, steel sash and glass block walls of the original unit are of brick, wood sash and cement-asbestos board in the extension. The original factory has an insulated metal roof deck, which was changed to precast cement tile when the extension was built. In fact, few critical items remain in this last unit; wood doors and stairways replace their steel counterparts; felt roof flashing is substituted for copper; partitions are of cinder block, wood or asbestos-cement instead of steel; and even the louvres in the walls of the fan rooms are made of wood instead of metal.

The plant is rectangular in plan with its long axis running east and west. Basic decisions as to layout, arrived at after numerous alternate studies, were to divide the framing into bays 40 ft. wide and 80 ft. long; to provide 15 ft. clearance from the floor to framing; to use vertical-sided monitors running lengthwise, centered on the column lines, and to make them 15 ft. 6 in. wide by 8 ft. 9 in. high; to make the outside bay along both long sides of the building two stories high, devoting the first floor to entrances and stairways and the second or clerestory to locker and toilet rooms; to provide entrances at 160 ft. intervals on both sides of the building; and to use a series of penthouses one bay or 40 ft. wide and 60 ft. long. In general the layout is symmetrical about the longitudinal axis of the building.

The layout of facilities in the outside clerestory bays is of particular interest. Each first floor entry is about 35 ft. wide and accommodates a central hall flanked on either side by a stairway. On the second floor these same spaces are occupied by the toilets, while on either side are located the locker rooms. By this arrangement no single locker room or toilet is unduly large, and what is particularly important, men and women may be completely segregated since any given number of entrances to the plant may be assigned to either sex. Some variations occur where it was desired to provide space for a classroom, a laboratory or the like, but in general this layout obtains throughout the two long sides of the plant. Natural light is admitted to these areas through clerestory windows on both the exterior and the plant sides.

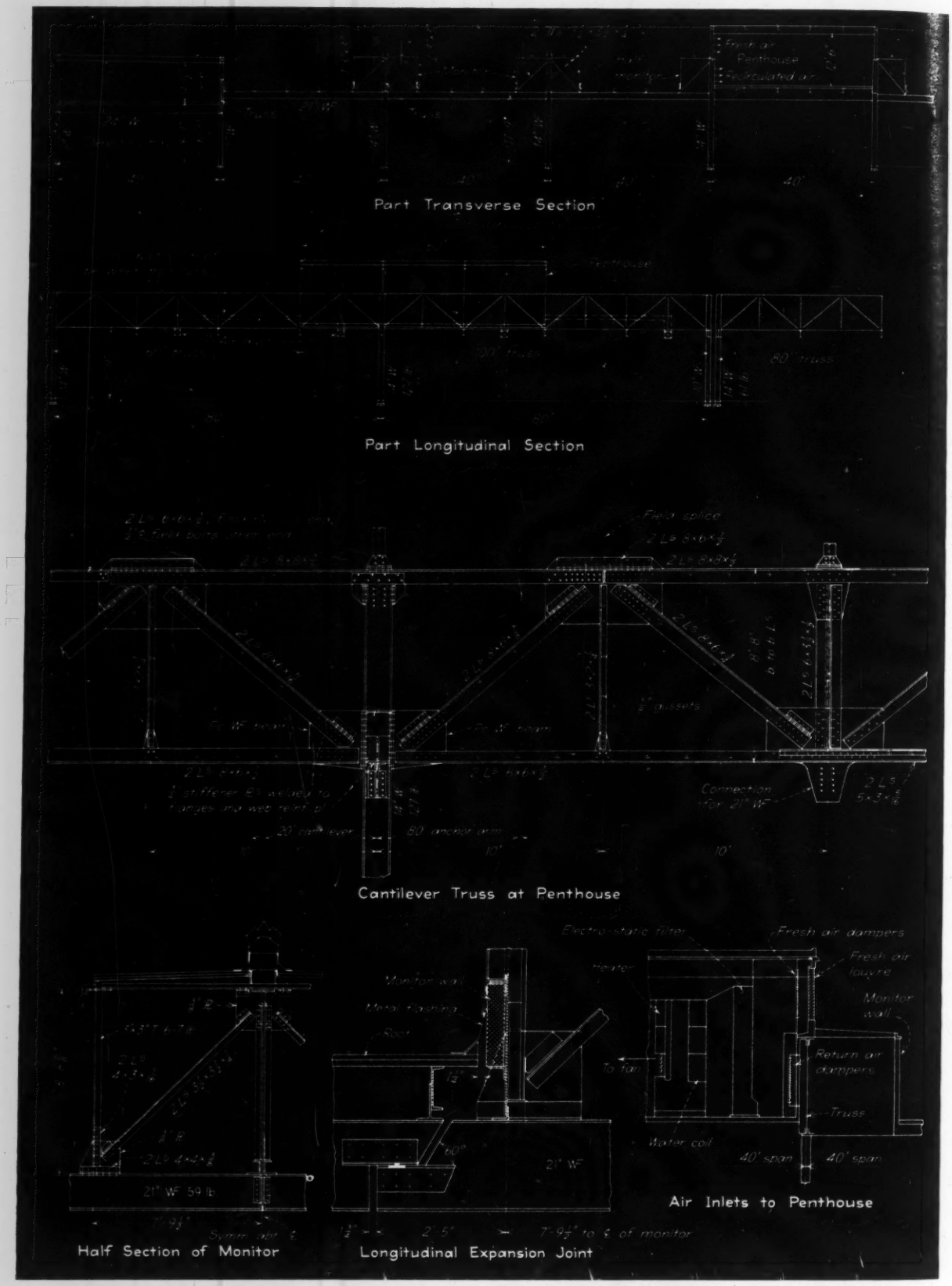


Fig. 2. Structural layout of factory involves bays 80x40 ft., cchieved by economical combination of truss and beam framing in which design of the penthouses played an important role.

Much study went into the steel framing design before the 40x80 ft. bays were chosen, and particularly before the unusual but very successful scheme of arranging the monitors to straddle the longitudinal column lines was worked out. The framing, as built, uses trusses for the 80-ft. spans, and rolled beams for the 40-ft. spans at right angles to the trusses. In addition to the beams that frame into the columns, three lines of beams frame into each truss at its quarter points, the connections being through extensions of the gusset plates below the bottom chords.

It was desirable to make these beams of minimum depth and weight, and through an ingenious method of giving them some supplemental support from the monitor framing, it was possible to use a 21-in. 59-lb. section for these 40-ft. spans. This support consists of double-angle diagonals running at 45 deg. from the top chord gusset plates of the trusses down to gusset plates on top of the beams, located 7 ft. 9½ in. out from the trusses.

In effect, therefore, each beam is supported at four points, the load from the end supports going to the bottom chord of the trusses, while the loads at the points 7 ft. 9½ in. away from the trusses go to the top chords. The double angles that support the beams are also the diagonals of the monitors whose side and roof members could then be made very light.

Another feature of the framing occurs in the support of the penthouses which, as stated, occupy a 40-ft. bay in width and are 60 ft. long. This 60 ft. length could have been positioned variously along the 80-ft. trusses, but after making numerous studies it was decided that greatest economy would result if 20 ft. of the length were placed in one span and the remaining 40 ft. in the adjacent span. The trusses beneath the penthouses were, therefore, transformed to cantilevers with an 80-ft. anchor arm and a 20-ft. cantilever. Continuity at the column was achieved by welding stiffener plates between the flanges and by using T-sections cut from wide flange beams for the truss-column connections. By this cantilever arrangement the increase in size of truss members required to support the penthouses was kept to a minimum.

In most other respects the framing was entirely conventional, a possible exception being the use of both longitudinal and transverse expansion joints, which divide the building into sections 320 ft. long and generally 230 ft. wide. The transverse joints are accomplished by the use of double columns while the longitudinal joint detail is made by cutting the 21-in. beams just outside the wall of a monitor, providing a sliding connection.

Distinctive walls

The walls are of interest principally because of the unusual number of materials used, which, by their variety, give the building much of its distinctive appearance. A 3½-ft. high base of brick backed by tile is capped with a concrete sill on top of which is an 8½-ft. height of window opening, of which the lower 3½ ft. is projecting steel sash glazed with clear glass while the upper 5 ft. is filled in with glass block.

In the latest addition to the plant, as previously stated, wood sash is substituted for the steel, and cement-asbestos board replaces the glass block. The upper part of the wall continues the tile-backed brick except that on the long sides a line of clear-glazed sash is inserted for the clerestory windows. The monitor walls are also enclosed in glass block, changed to cement-asbestos board in the latest addition.

One of the important details of the walls relates to blackout provisions. Removable sheet metal or plywood panels may be used for all of the glass block areas, and lightproof shades may be installed behind the steel sash. The substitution of cement-asbestos for the glass block in the factory extension, of course, greatly reduced its blackout problem.

One of the important by-products of the framing arrangement, in which the beams are framed into the trusses below their bottom chords, was that the air conditioning ducts could be installed within the depth of the beams and thus not encroach upon the headroom. Then, by placing all piping, including the sprinklers, in the plane of the truss bottom chord, these utilities too, were out of the way and easily accessible. Buses for electrical connections for machines are attached to the bottom flanges of the 21-in. beams, and the troughs for the fluorescent lights, which provide 40-ft. candles throughout the factory, are hung parallel to the buses and at the same elevation. By this arrangement each type of service is entirely separate from the other, and yet the installations are so compact as to make maintenance easy on all of them. The compact layout also enhances the interior appearance of the factory.

The design studies mentioned previously, which were made to determine the most economical location of the penthouses from a structural standpoint, also took into account the most efficient arrangement for the air conditioning equipment that they were to house. Two major results of these efforts are that the supply lines from the fans to the main ducts that run transversely across the building on 40 ft. centers are unusually short; and that the arrangement of the two sets of louvres, through which fresh air from the outside and recirculated air from the inside are admitted to the air conditioning equipment, is very compact (Fig. 2).

It was determined that each fan room should serve two of the main transverse duct runs and studies showed that greatest efficiency would result if a fan were located directly over one of these runs; one supply line could then drop vertically into this run while the other could be led out through the end wall of the fan room, over the roof and down to the next run 40 ft. away. Carrying this latter discharge over the roof was preferred to duct work in the monitors in order that daylight from the glass block monitor walls would not be obstructed. Electrostatic airfilters feature the air-conditioning system.

As to the louvres, their compact arrangement results from the fact that the longitudinal walls of the fan rooms extend above the roofs of the monitors. These walls, therefore, are outside the building in the upper half of their height and inside the building in the lower half. Louvres placed in the upper half would, consequently, admit outside air to the fan room while directly below could be installed louvres to admit recirculating air from the inside of the factory. The mixing chamber at the inlet end of the air conditioning equipment could then be backed directly against this wall, eliminating any need for inlet piping within the fan room itself.

The plant, which was financed by the Defense Plant Corp., was designed and constructed by Stone & Webster Engineering Corp. in collaboration with the owner's architectural supervisor, N. N. Culin.

Fig. 1. Asbestos-cement sheets were substituted for critical plywood at a Navy camp. Best method of cutting sheets is by marking with a knife, then breaking along a straight edge. Cutting into the surface from each side is recommended to secure a smooth edge.

Navy Camp Built from Non-critical Materials

***Contents in Brief**—Thin asbestos sheets over plaster board and tarpaper provide an attractive, fireproof wall for Navy buildings at a cost of 15c. per sq. ft. for material and labor. Glued, laminated arches form the ribs for a 120-ft. span drill hall. General contractors completed the entire camp supplying everything from railroads to dishes.*

SUBSTITUTING asbestos-cement sheets of $\frac{1}{4}$ in. thickness for the $\frac{5}{8}$-in. thick plywood originally specified for exterior sheathing, the contractors for the Navy's Camp Bainbridge, Md. were able to eliminate the more critical wood. An attractive, fire-resistant structure that will require practically no maintenance resulted, and substantial savings in first cost were made. Asbestos-cement sheets are used on the exteriors of all buildings at the camp and for the interiors of all washrooms and stairways. It is also used as a wainscot, up to a height of 4 ft., in mess halls, school rooms and in the hospital ward rooms. Readily available wallboard is used for the interior walls and ceilings, replacing the $\frac{3}{8}$ in. plywood that was specified.

Contract for construction and furnishing a complete, ready-to-operate, camp was awarded to the Chas. H. Tompkins Co. on a fixed fee basis. As the general contractor, they are doing all the building construction with their own forces, but have sublet substantial contracts on invited bids. Work done under subcontract includes plumbing, heating, electrical work inside the buildings and other items or repetitive structures where complete plans were available for estimating. Special structures and exterior electrical construction were not sublet.

The general contract includes over 330 buildings, all utilities, a railroad and complete equipment for the camp; the latter requires purchase and installation of all housekeeping and camp furnishings from salt shakers up.

Camp Bainbridge is located in rolling country near Port Deposit, not far from Havre de Grace, Md., and is partly on the grounds of the historic Tome Prep School. The buildings are located as the terrain permitted over a 1,070-acre tract and are divided into complete groups.

Each of the groups is a center for 5,000 sailors with the buildings laid out around a 600 ft. by 1,200-ft. drill field. Each unit is a complete camp in itself with a 5,000-man mess hall, drill hall of unusual design, barracks, officers' quarters, warehouse, dispensary, ship's service building (equivalent to the army post-exchange), administration building and "scrub decks" (nautical term for laundry).

Asbestos-cement flat sheathing

Large quantities of asbestos-cement sheets are used in nearly all the buildings, total shipments to the job exceeding 6,500,000 sq.ft. or more than 200,000 pieces, 4x8-ft. in size. Most of this material is $\frac{1}{4}$-in. thick, flat sheets of natural cement-gray color with enough marking to make it attractive. A special, smooth finish grade, $\frac{3}{16}$-in. thick, is used to line the walls of the operating rooms of the hospital, and other places where a glazed surface is required for cleanliness or appearance.

Typical of the construction at the camp are the 2-story, flat-roofed, structures designated as 232-man barracks but accommodating about 250 men when the petty officers quartered there are included. The buildings are 42 ft. by 150 ft. outside dimension, and generally rest on concrete pedestal columns, spaced 14½ ft., 13 ft. and 14½ ft. transversely and 15 ft. longitudinally. The pedestals are set on 2½-ft. square poured concrete footings that are 18 in. thick.

The buildings are supported on 8x16 in. timbers along the interior

rows of columns and 4x16's at the exterior. The same size members support the second floor. For some of the buildings, where the height from footing to the floor grade was not great, continuous 16-in. wide, brick or concrete block walls were laid on poured concrete footings. This arrangement was used to reduce the number of heavy timber girders by eliminating those normally required under the first-floor beams. Where the latter type of construction was used, the brick or concrete walls run longitudinally in four lines the full length of the building, but the ends were generally left open.

Floor joists under both the first and second floors are 2x10's at 16 in. c. to c. The timbers used were long enough to lap over the interior stringers. Floors were designed for 2-in. thick rock-wool insulation to be applied in made-up mats stapled to the floor joists and followed at once by installation of subfloors; finished hardwood flooring was to be placed after the building was complete. Extensive rain during the construction period, retained on the mats by their waterproof cover, made necessary a change in construction procedure. Therefore, insulation ½ in. thick laid on top of the sub-floor was substituted for the underfloor insulation. Wood

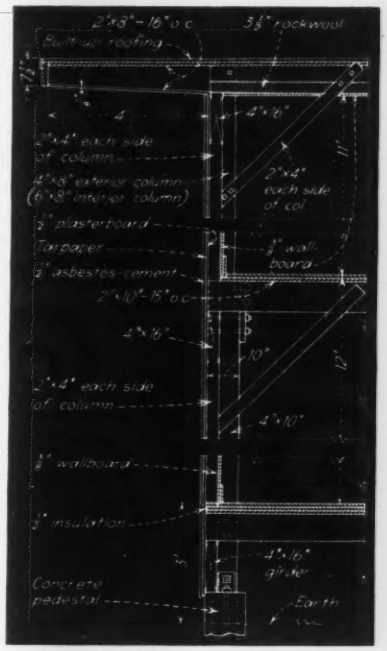


Fig. 2. Typical barracks wall, after design revision to save plywood.

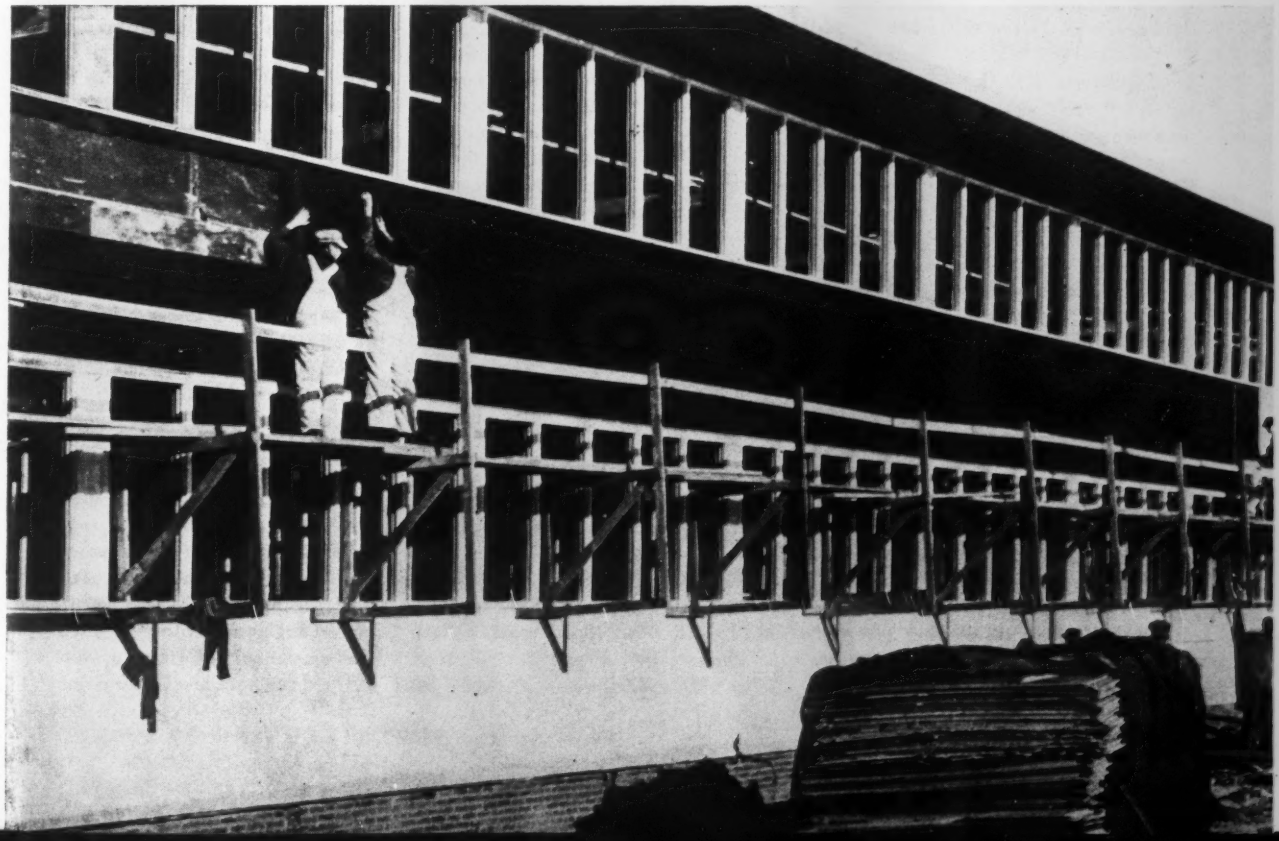
strips, ½x1-in., were nailed over each joist to support the finished floor. The second floor was designed similar to the first, except that only a layer of building paper was used between the sub-floor and finished floor.

Walls were built in place using precut lumber, the men working on the sub-floor of each story. Wall studs are 2x4's at 16 in. c. to c. On the outside of the studs there is a ½-in. thickness of plaster board, a layer of tarpaper and over this ¼-in. thick asbestos-cement sheathing. The plaster board was in 2-ft. wide pieces, laid horizontally and the tarpaper, also applied horizontally, was unrolled and tacked on as shown in Fig. 3.

Provision was made for considerable natural light in the buildings, nearly one-half of the wall area being double-hung, wood-frame windows. Frames were prepared in a mill on the site and delivered to the buildings ready to set in place. The asbestos-cement sheets slip into a groove provided under the sill to form a waterstop. Over the top of the window frames, a strip of tarpaper was used as flashing.

Asbestos-cement sheets were available only in 4x8-ft. size and were cut as required on the job. No consideration was given in the original design to matching the size sheets available to the use intended. Considerable cutting was necessary, however waste was kept to about 5 percent by proper planning for use of the pieces cut off. In the past, asbestos-cement sheets generally have been cut with

Fig. 3. Exterior walls of the Navy barracks are ½ in. plasterboard, tarpaper and ¼-in. asbestos-cement sheathing.



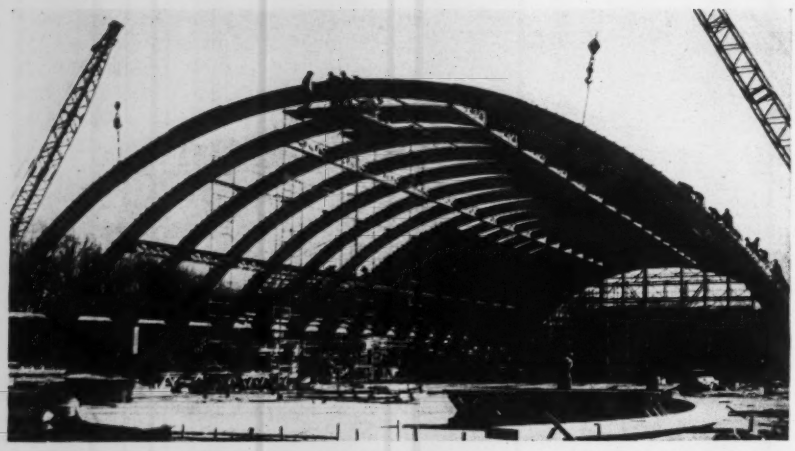


Fig. 4. Drill hall of 120-ft. span is built over glued, laminated arches. These were manufactured in Wisconsin and shipped to the site in two sections for erection.

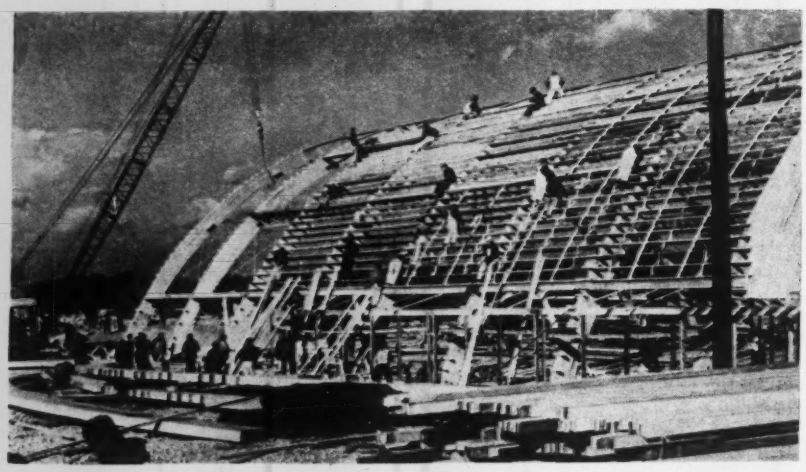


Fig. 5. A built-up roof is placed over 1x6-in. sheathing bent over 2x10-in. rafters laid around the curve of the 63½-ft. radius arches.

a carpenter's saw, by special blade on a circular saw, or by use of a carborundum wheel. The method now preferred is to make a deep scarf on both sides of the sheet with a curved blade linoleum knife, which makes it possible to break the material readily along a straight line. A single cut on one side is sufficient to break the material, but a smoother break is assured by the double cut.

The 4-ft. wide asbestos-cement sheets were joined at each third stud. Lap or battened joints were not used; instead, a ribbon of plastic caulking compound was placed along the joint line and the sheets pushed together. The compound filled the joint completely and makes it weathertight. No painting or other treatment of the exterior surface was used, the natural light gray of the asbestos-cement sheathing making an attractive and permanent surface.

Asbestos-cement sheathing costs 5 to 6c. per sq. ft., compared to about 10c. for the ⅝-in. resin-bonded plywood originally specified for the exterior walls. The asbestos-cement sheets cost more than twice as much a year or so ago as they do now. Mass production and some modification of the material has made the reduction in cost possible and made its use competitive with lumber products. Cost of placing is about the same as that of plywood, roughly 3½c. per sq. ft. for labor. Plasterboard is 3c. per sq. ft. and placing cost is an additional 2½c.; tarpaper costs ½c. for material and ½c. for labor. Thus, the exterior covering for the wall costs about 15c. per sq. ft.

Interiors of the buildings are finished with ⅜-in. thick wallboard or plywood, nailed directly to the studs. Where the asbestos-cement sheets are used as a wainscot they are tacked over the wallboard, the 4-ft. width forming the height used. The asbestos-cement sheets are used by themselves in the washrooms, etc., caulking compound being "buttered" on the edge of the sheets to make the joints watertight.

Roofs of the buildings are flat, the framing consisting of 2x8-in. joists at 16-in. centers and carried on 4x16-in. longitudinal stringers on the same lines as stringers for the first and second floors. The building is covered with 1x6-in. D&CM boards nailed to the joist and surfaced with a 4-ply built-up roof covered with broken slag or small gravel. The underside of the ceiling is wallboard and is insulated with 3½ in. thick bats of rockwool in the 8-in. deep space between the ceiling and roof.

Laminated arches for drill hall

Of special interest are the 120-ft. by 625-ft. drill halls with the roof built over laminated timber arches that have no interior support. Arch ribs are made up of about 37 pieces of 1x8-in. lumber glued together under pressure to give a net section 30 in. deep by 7½ in. wide. The ribs are somewhat less than one-half of a circle, having a 63½-ft. radius with the crown of the arch only 41 ft. high above the tie between the pedestals and 39 ft. above the finished floor. The arches were fabricated in two sections, each about 74 ft. long measured around the arc, at a mill in Wisconsin and shipped to the job by rail. Each section was lifted to position by a crawler crane and the two pieces joined by a relatively light splice, as the stress is theoretically only direct compression. Four trusses and the same number of T-beams, all of timber, are used between adjacent arches to stiffen the building longitudinally.

The arch ribs are 16 ft. c. to c. and are supported on poured pedestals on footings 3 ft. 3 in. wide by 6 ft. 6 in. in the direction of the arch. The foundations are joined under the floor of the building by five ¾-in. round reinforcing bars encased in concrete.

For most of their length, the drill hall floors rest on the ground over a 6-in. layer of crushed rock or gravel, followed by 6 in. of concrete in which wire ties are inserted. A mopped-on coat of pitch, 1 lb. per sq. ft., was placed for damp-proofing, and 3x4-in. timber sleepers at 16-in. centers were wedged to exact level and temporarily

tied down by the inserted wires to support the floor. Lean concrete was placed as a fill between the sleepers and a diagonal sub-flooring nailed to them. End-matched maple was used for the finished floor.

Along the sides of the building, where the arch construction provides only limited head room, an area 16 ft. wide and the full length of the structure is housed-in to provide offices, lockers, washrooms, storage and general utility space. Enclosure is made with ¼-in. thick asbestos-cement sheathing over ½-in. plasterboard for the exterior and ⅜ in. thick wallboard for the interior and ceiling, nailed to opposite sides of the same studs. Where used for offices the space is divided into separate rooms by partitions at each arch location, 16-ft. c. to c.

At one end of the drill hall is a 50x75-ft. swimming pool. Its top is at the level of the floor of the building. In this area resistance to the thrust of the arch is provided by tying the reinforcing into a heavy concrete slab that forms a frame around the pool. On one side of the pool a heating plant is located and on the opposite side locker and shower space is provided. The huge hall is heated by blower units located above the side enclosures with the fans directed over the drill floor. Part of the heat from the blowers is directed through ducts to holes cut in the ceilings of the side enclosures to warm the space below.

Extensive earth moving

A railroad eight miles long with 225 ft. of rise in 3½ miles of the line was a major part of the construction. Earth handling amounted to more than 100,000 cu.yd. to the mile for the single track line with maximum grades 1½ percent. The road will serve to handle all supplies for operating the camp and will make it possible to detrain and entrain personnel within the Navy-controlled area.

Extensive grading involving nearly 3,500,000 cu.yd. of earth moving was required to adapt the site to its intended use. More than 100 excavating machines of all types, supplemented by up to 300 trucks, were used to handle material ranging from silt to solid rock. One large hill of naturally well-graded gravel provided surfacing material for the necessary temporary roads and most of the permanent roads of the camp. Camp roads, however, have additional surface treatment to keep the dust down.

Utility installation at the project involved some very unusual construction. Water is available only from the Susquehanna River, some 400 ft. vertically below the project and a mile away. High-pressure pumps and fittings were required, as the pressure needed to raise the water to a job reservoir is about 180 psi. It was impossible to get new pumps immediately, or to find existing equipment suitable for the volume and pressure required. The Tompkins Co. evolved a scheme of welding an extension to one end of the existing shaft of a large electric motor to drive a pump at each end. A two-stage, direct-connected unit was made from two suitable pumps available and the assembled unit was functioning months before new equipment could possibly be obtained. This pump was temporarily installed outside the regular pumphouse so that the four new machines ordered could be placed in operation without disturbing the specially built pumping unit.

Water is delivered to an existing open reservoir and then treated as it flows to an adjacent new concrete lined reservoir 177x289 ft. in plan and 13-ft. deep. A wood cover protects the water, and pressure is maintained by a 500,000 gal. elevated tank.

Complete treatment for sewage

Sewage disposal from a camp as large as a medium-sized city presented its own problem. The original plan was to discharge partly treated sewage into the considerable volume of the water flowing in the Susquehanna River, but this was not approved by public health authorities.

An outfall sewer, carrying the disposal into the bay, was investigated and abandoned as it required nearly five miles of rock tunnel. Thus, complete treatment of the sewage was the only suitable method of disposal.

The plant built has three 50-ft. dia. primary clarifying tanks, a 60-ft. dia. sludge digestion tank, and three 40-ft. dia. final clarifying tanks, all of concrete. Three rotary sprinkling filters of 160-ft. dia. and 7-ft. deep have 13-in. thick walls of brick, the latter being substituted for reinforced concrete construction to conserve steel. The contractor found the cost of brick construction to be less than was estimated for concrete. Four, 40x160-ft. glass covered, sludge-drying beds are provided, creosoted lumber being used to carry the wood sash.

Personnel

General contract for the construction is held by Chas. H. Tompkins Co. of Washington, D. C. for whom Francis M. Tompkins is project manager and Henry Allan is general superintendent. Frank Glueck is mechanical engineer in charge of all utility and mechanical equipment and installation. L. A. Dill, Jr., and John Sonneborn are assistant superintendents and K. P. Morris is office manager. Architect-engineers for project are Eggers & Higgins, New York.

Lieut.-Comdr. Jos. White (CEC), USN, is resident engineer in charge at Camp Bainbridge and Capt. Ira P. Griffin (CEC), USN, is officer in charge of construction for the Potomac River District of the Navy.

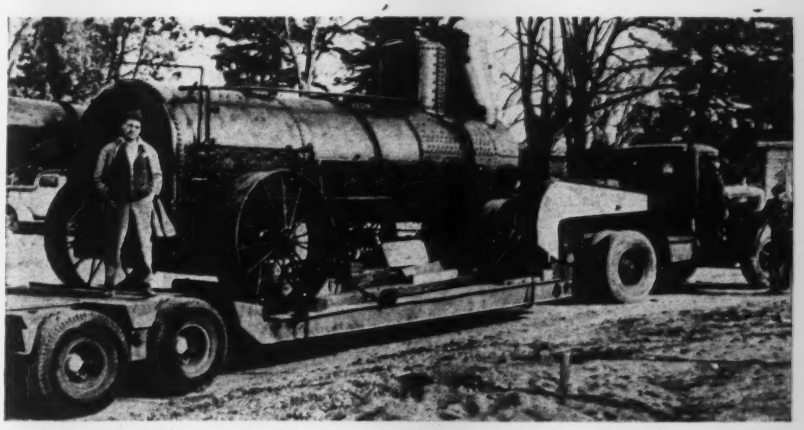


Fig. 6. Demand for a mess hall two weeks ahead of schedule necessitated providing a boiler to supply steam. The rush order came through at 3 p. m.; the nearest boiler was found in New York City and was on the work at 10 a.m., delivered by a New York trucker.

Fig. 1. Completed flight strip of plant-mix surface type. Shoulders and end areas are stabilized but not surfaced.

How Flight Strips Are Being Built

***Contents in Brief**—Rapid progress is being made in completing the $10,000,000 flight strip program that Congress authorized a year ago. Most of the strips are in seaboard states and all are located in accordance with military requirements. The Public Roads Administration is exercising design, and supervisory control through a special Flight Strip Division, and state highway departments are handling the field work through contractors. Stabilized local materials are used for sub-bases, and most surfaces are of bituminous type although concrete is also used.*

FROM FLORIDA TO CALIFORNIA and from Maine to Montana a small army of engineers and contractors' crews have been in the field since last May doing substantially the same thing in a dozen or more different ways. They are building the flight strips—auxiliary landing areas for aircraft—that comprise the $10,000,000 program authorized by Congress in the Defense Highway Act of 1941 and, although each flight strip is the same in so far as layout, facilities and major dimensions are concerned, every one presents a different construction problem because of the requirement that on-the-site or local materials be used as extensively as possible. Subgrades vary from sand-clay to crushed lime rock, and surfaces from sand-asphalt to concrete. Costs likewise vary, upper and lower limits being about $600,000 and $200,000 respectively, with land costs contributing substantially to the expense of the higher priced strips.

The flight strip program is in charge of the Public Roads Administration of the Federal Works Agency, Congress having stated that "the Commissioner of Public Roads is authorized to provide, in cooperation with the Army Air Corps, for studies and for the construction of 'Flight Strips' . . ." To handle the work, Thomas A. McDonald, PRA commissioner, set up a special department, the Flight Strip Division, with Fred E. Schnepfe as director, and it is this division that is responsible for location, design and construction, subject to Army Air Forces cooperation and approval. Field supervision is exercised by the regular personnel of the PRA district offices, while the actual field work is handled by the various state highway departments who let the jobs to contractors under about the same procedure that is followed on federal-aid road work.

What are flight strips; what is their purpose; how are they designed; and how are they located and built? These are some of the questions that this article attempts to answer. The construction methods used on several different flight strips are also described.

A flight strip is defined as an area of land with clear approaches, located adjacent to a public highway, for use as an auxiliary landing area for aircraft. At present, flight strips have a definite purpose as dispersal fields for military aircraft, and may also be used for both operations and training, but in peace-time flight strips can serve as landing areas for commercial and private airplanes in regions where the cost of a more complete field would not be justified. Although a flight strip provides only one runway, this is carefully located in the prevailing wind direction, which experience shows will make the field available for safe operation during the greater part of the year. Furthermore, the tricycle landing gear with which more and more planes are being equipped make "off-wind" landings relatively safe, and this will increase further the number of days that a single-runway field can be used.

Flight strip details

The general specifications covering flight strip design require that the

strip shall be as nearly 8,000 ft. long as is feasible and that the width shall not be less than 500 ft. nor more than 1,000 ft., with a width of 800 ft. as desirable. Within this flight strip a paved runway 150 ft. wide by 4,000 ft. long (at sea level) is to be used. As the elevation of the site increases, the length of the runway is increased, until at 5,000 ft. elevation runway length is 6,500 ft. and at 8,000 ft. elevation it is 8,000 ft. In addition to the flight strip itself an approach zone at either end, two miles long, 4,000 ft. wide at its outer end and 500 ft. wide at its inner end is required within which there shall be no obstacles extending above a 30:1 glide angle, or 40:1 is possible.

The paved runway length is also extended at each end for a distance of 1,000 ft. and a width of 150 ft. by stabilized soil surface. The purpose of these extensions is to provide additional runway at low cost for those planes that require it. However, it is stipulated that the use of surface materials similar to those in the paved runway is to be avoided so as not to confuse the pilot into believing that these areas are provided for regular landings and take-offs. The specifications also require that the shoulders along the runways be stabilized, the widths varying according to local conditions. All other areas within the flight strips are to be graded only.

Specifications set longitudinal runway grades at 1½ percent maximum, with 1 percent or less desirable. Where changes in grade are used, the maximum rate of change is ½ percent per 100 ft. station. Vertical curves are limited to 500 ft., and every effort is made to secure 1,000-ft. tangent intervals between vertical curves. Other grades and dimensions are shown on the typical cross sections of Fig. 3.

Location procedure

In so far as the present program is concerned, flight strips are located in accordance with the needs and wishes of the American Air Forces. These locations, however, are usually designated on an area basis (perhaps 100 sq. mi.), with the exact location left to the Public Roads Administration, subject to A.A.F. approval. All programs clear through the Flight Strip Division office in Washington and are then sent to the respective PRA district offices. Here the district engineer, accompanied by an engineer of the highway department of the state in which the flight strip is to be located, visits the area designated and makes a tentative selection of the site; usually an engineer from the Washington office of the PRA assits in this work.

As soon as the tentative selection of site has been made, it is examined by a local A.A.F. officer and, if approved, the PRA district engineer submits a report to the commanding general of the Air Force area outlining the location; air distance from the nearest airport or airbase; prevailing wind conditions and supporting weather data; location and height of obstructions in area surrounding the site; general classification of soil; information on natural drainage; elevation of the site; and estimated cost and estimated time of construction.

When this report has been approved by the commanding general of the Air Force area, it is forwarded to the headquarters of the Army Air Forces in Washington where it is approved or rejected, and the Washington PRA office advised of the action taken.

Other more detailed studies are then made and submitted to the PRA Washington office for approval, and the work is ready to begin. The actual field work is carried out with the cooperation of the state highway department in a manner similar to that used in the federal-aid highway program, the highway department being requested to assist in site selection and acquisition of sites, in preparing preliminary and final plans and specifications, in making estimates of costs, in calling for bids and awarding contracts, in supervising construction and arranging for maintenance of the completed project.

Design considerations

Wind and weather information ranks first in importance among flight strip design considerations, while next on the list are soil and topographic features. With respect to wind and weather, rainfall and snow conditions

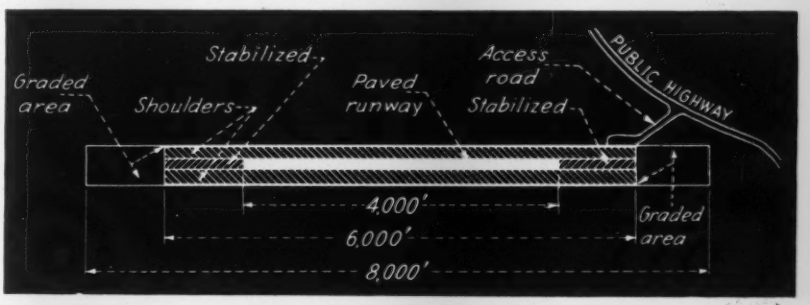


Fig. 2. Typical layout and dimensions of a flight strip at sea level. All flight strips are accessible to public highways for servicing and maintenance purposes, and are oriented in the direction of the prevailing wind.

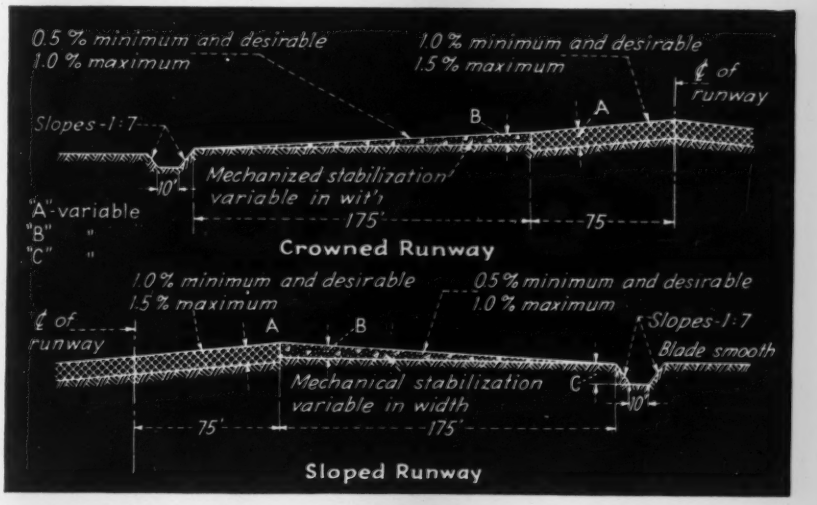


Fig. 3. Typical half sections of flight strips showing grades and dimensions. Surface drainage and side ditches may sometimes be supplemented by underdrains at edges of runways.

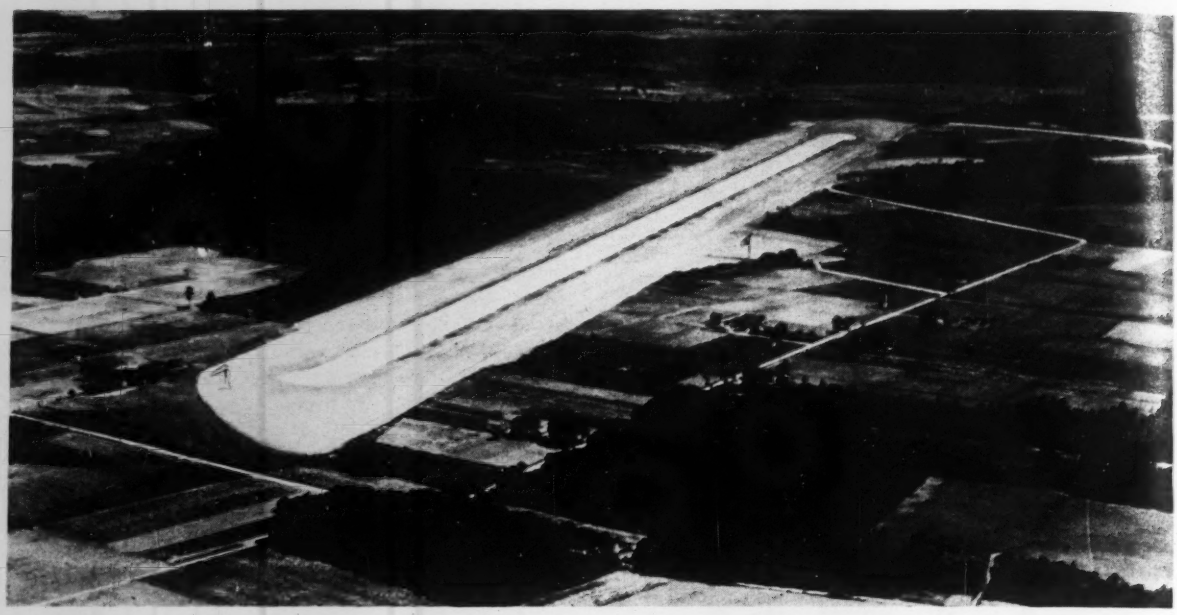


Fig. 4. Flight strip from the air. The runway in this instance is of concrete, with stabilized sodded and seeded shoulders.

are carefully analyzed for a period of at least ten years previous; and data are obtained to show the percentage of cloudy, partly cloudy and clear days and the number of days that fog may occur in each of the four seasons of the year. Wind records are also compiled for each of the four seasons of the year and recorded on wind rose diagrams, which show not only wind direction but indicate the percentage of the time the wind blows toward the center of the rose. They also indicate wind velocity.

In the selection of a flight strip site, availability of suitable construction materials, such as gravel, sand and stone deposits, plays a prominent part, provided the soil and aeronautical features are satisfactory. In the program as developed, almost every type of soil has been encountered, and flight strips are being built on soils as poor as A-7.

By careful site selection it has been possible to reduce artificial drainage facilities to a minimum. The fact that a flight strip uses only a single runway greatly simplifies the drainage structures. In many cases only the ditches at the outer limits of the shoulders (Fig. 3) are required. If drains are needed along the edges of runways, open joint pipe is usually laid in a trench backfilled with gravel or crushed stone to within 12 in. of the surface and then covered with course stone premixed with bituminous material.

In general the details of runway construction, grading and drainage do not deviate materially from standard highway practice. However, the heavy wheel loads that are to be expected require very thorough supervision of subgrade compaction and selection of material. Furthermore, drainage is probably somewhat more important than on highways. It is also pointed out that the usual practice for allowing for impact loads on highways is not applicable to runways because of the effect of wing lift. Inasmuch as experience shows that surfaces that sustain static airplane wheel loads do not fail under the forces of landing airplanes, there is a trend away from the use of any impact factor whatever.

The structural design of flight strip runways is predicated upon the best information available.

Pavement thicknesses

On flexible type pavements, for the heavier wheel loads and the soils of low bearing power, a total thickness (surface and sub-base) of as much as 24 or 30 in. may be required whereas for lighter loads and better soils as little as 6 to 10 in. total thickness may be adequate.

General surfacing to be used is that which will most economically meet the requirements for the runway pavement. Unusual requirements for smoothness must be met so that there will be no opportunity for water to collect and remain in puddles on the runway.

First importance attaches to the production of a subgrade that will have uniform bearing power capable of supporting the maximum design loads. Soil-aggregate base courses may be sand-clay mixtures, gravel, stone or slag screenings or sand; crusher-run gravel; crushed stone or slag combined with soil mortar; or any combination of these materials. Local material such as caliche or lime rock have also been used in base courses.

In coastal states and other localities where Bermuda grass, Buffalo grass and similar grasses are prolific, it has been found advisable to treat the subbase with tar or to saturate it with a hot brine solution to prevent grass from penetrating to the surface.

While the shoulders in no case should be less than 150 ft. wide, it is not always necessary that mechanical stabilization be carried the entire width—ordinarily stabilization is carried about 75 ft. from the edge of the runway. Shoulders are primarily "runover" areas. It is therefore necessary that the greatest stabilization should be adjacent to the paved runway, decreasing from that point to zero at the ditch-line. Generally a uniform depth, extending from the edge of the runway across the shoulder for a width of 50 to 75 ft., then decreasing as it approaches the outer edge of the shoulder, has been found suitable for the conditions to be met.

Over both stabilized and unstabil-

ized areas, it is frequently desirable to seed, sprig or sod when the soil and general weather conditions are such that grass will grow. Elsewhere, a bituminous "dust-layer" is utilized over stabilized areas, care being taken to distinguish them from the runway by a painted stripe at the runway edge or by using light colored aggregate in the bituminous runway surface.

Construction methods

The principal construction operations are clearing, grubbing, grading, drainage and paving, with grading and paving being both the most important and expensive as well as the most time consuming. Optimum compaction of embankment is regarded as the key to a successful flight strip, but much care must also go into the surfacing operations. Although concrete has been used, flexible-type surfaces are the rule. One common type has been a plant-mixed bituminous surface laid to a minimum compacted thickness of 2 in. Others are extra heavy surface treatments for light traffic, penetration macadam, road-mix, or mixed-in-place. Also sand-asphalt and other types of open and dense-graded bituminous mixtures have been found acceptable when satisfactory local aggregates are available. As examples of this work, brief mention may be made of work at three of the flight strips, two in the eastern United States and one on the West Coast.

A concrete flight strip

The first flight strip completed was one with a concrete runway designed to be suitable for the Army's heavy bombers. Located on the eastern seaboard, it is 8,000 ft. long by 500 ft. wide and contains a runway 150 ft. wide by 7,000 ft. long, obviously meeting the A.A.F.'s description of a flight strip as "a dispersal area for military aircraft, a staging point for long flights involving supplies, equipment and troops, an interceptor base to ward off possible bomber attacks, and an operational point for costal patrols."

This particular flight strip was completed in the fast time of 57 days. Although the site was relatively flat, grading for excavation and fill totaled 213,000 cu. yd. Considerable heavy clearing and grubbing were also required at one end of the site.

The soil at the site was of A-2 classification so that no outside material needed to be brought in. The entire subgrade to a depth of 10 in. was disked and compacted by sheepsfoot and 10-ton tandem rollers to 95 percent theoretical density at optimum moisture, ready for the surfacing operation that was carried out with a 34-E paver in 25-ft. wide lanes. The speed with which concreting went forward is indicated by the fact that in one 12-hr. period the paver turned out 1,187 batches, while the average was in the neighborhood of 1,100. All paving was complete in 23 days.

Ribbon type contraction joints were placed transversely every 20 ft. between ¾-in. expansion joints installed at 120-ft. intervals, consisting of greased dowels at 2-ft. spacing equipped with expansion caps. Key joints were used between the longitudinal lanes, the key being 3 in. high and 1½ in. deep.

As soon as the paving was complete, a 50-ft. strip of shoulder on either side was covered with 4 in. of native top soil. This was fertilized and watered and then covered with a mixture of Bermuda and local grass by broadcast sodding, finally being covered with a mulch. The remainder of the shoulders out to the side ditches was merely graded and seeded. No underground drains were used on this flight strip, the 0.8 percent transverse grade on the slab and the 1.2 percent grade on the shoulders being counted on to carry the surface water to the ditches.

Sand-asphalt on sand-clay base

At another eastern site where an A-2 soil was encountered, it was decided to use this for a subgrade, cover it with a sub-base of borrowed sand-gravel-clay material and to surface with a sand-asphalt plant mix. A nearby pit yielded the necessary sand-gravel-clay which could be adequately mixed merely by running it through the shovel dipper a couple of times. And another pit provided a satisfactory bank run sand for the plant-mix surfacing material.

Using the material on the site, which was sand-clay mixture rather heavy in clay, a 10-in. deep subgrade was constructed over an area of 6,000 x150 ft., providing for a 4,000-ft. surfaced runway and 1,000 ft. unpaved but stabilized "overshot" areas at either end. This subgrade was worked to a maximum density at optimum moisture by disks and sheepsfoot rollers, in cases aided by scrapers. A density of from 115 to 120 lb.

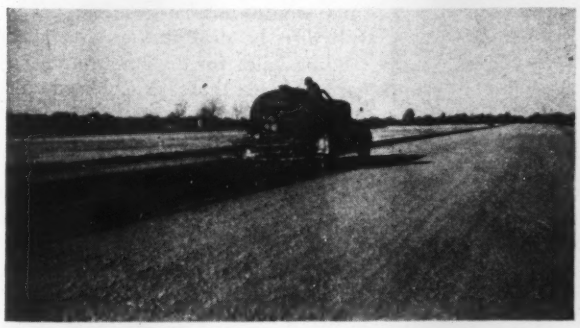


Fig. 5. Operations in constructing a plant-mix surface on a prepared sand-clay base. Top, dumping and spreading the borrow material for the sand-clay base. Left, priming the base with tar. Right, paver laying the sand-asphalt surface on the prepared base.

per cu. ft. was achieved. The maximum fill required anywhere on the site was only 3 ft.

On top of this subgrade in the runway area there was then placed a sand-clay sub-base of the borrowed material, dumped in a 11-in. thick layer and compacted to 8 in., giving 108 to 115 lb. per cu.ft. density, about 95 percent of theoretical. A thinner layer compacted to only 6 in. was used on the approach or "overshot" areas at either end of the runway.

At times it was found that not enough clay had been added at the borrow pit through the mixing afforded by the shovel bucket. It then became necessary to add clay in the field, which was mixed into the soil by a special tractor-hauled machine equipped with rotating cultivator blades.

All of the base work was handled by building one half, or a 75-ft. width, of the runway down one side and returning on the other side. Surfacing followed the same sequence. First a tar prime in the amount of one-third gal. per sq. yd. was used on the base, followed seven days later by the sand-asphalt plant-mix, which was rolled to 1.8-in. thickness. The mix used ⅜-in. maximum size aggregate and an 85-100 penetration asphalt in an amount equivalent to 7 percent. About 175 lb. of sand asphalt per sq. yd. of surface was used. A total of 6,000 tons of plant-mix was placed on the flight strip at the rate of 350 tons per day.

Plant-mix on gravel base

On a West Coast flight strip considerably more site preparation was required than on the two eastern jobs described above, but the same high standards of subgrade compaction were sought. Thus, all stumps and large roots were removed regardless of the height of fill, and all embankment was required to be built in 6-in. maximum layers to a relative compaction of 85 percent.

This flight strip also had dimensions of 8,000x500 ft., and it was stipulated that the center 350 ft. of this width for a length of 6,000 ft. should be provided with a sub-base made by the addition of imported borrow to a depth of 1 to 2½ ft. All of this borrowed material was required to be of a sandy or gravelly character that would compact readily under watering and rolling in 4-in. layers to at least 95 percent relative compaction. All such material had to pass a 3-in. sieve, and it was required that the cementing value for the top 4 in. should not be less than 100 lb. per sq. in.

Stabilized runway

On the central portion of this stabilized area, over dimensions 152 ft. x 4,000 ft., was placed a 9-in. layer of gravel, sand and binder that would pass a 2-in. sieve, with a maximum size no smaller than would be retained on a ½-in. sieve. Furthermore, not over 60 percent should pass a No. 4 sieve, with 3 to 11 percent passing a No. 200 sieve. This fill was placed in 6-in. layers and firmly compacted.

On this gravel base a bituminous plant-mix surfacing was then applied after a priming with 1/3 gal. per sq. yd. of type SC-2 asphalt. The paving asphalt, of 120-150 penetration, was then spread with a self-propelled mechanical spreader in 12 ft. widths, and rolled. The compacted thickness of 3 in. was laid in two equal courses. As a final operation the runway surface was sealed with 0.1 gal. per sq. yd. of asphaltic emulsion.

Fig. 6. Typical soil stabilization operations characterize flight strip work. Special borrow material is being spread along sides and at ends of the completed gravel base to provide safe "overshot" areas.

Conclusion

As a recapitulation of the flight strip situation these facts may be set down:

1. Col. Stedman Shumway Hanks is credited with originating the idea of flight strips and with promoting their acceptance by the federal government. The term "Flight Strip" is, in fact, copyrighted by Col. Hanks.

2. Originally urged as an aid to peacetime aviation, the first flight strips to be built are primarily for war use.

3. Flight strips are not necessarily, nor even frequently, *parallel* to highways, as is sometimes supposed. They are always *connected with* public highways, but their orientation is solely determined by the prevailing wind direction.

4. The controlling factor in flight strip design and construction is the subgrade. It is important that the subgrade have a uniform bearing power capable of supporting the maximum expected loads.

5. The present flight strip program is predicated upon the greatest possible use of site and local materials. Soil mechanics is the principal tool of the flight strip engineer.

6. Most surfaces are of the flexible type, using bituminous materials, although concrete slabs are used at some of the more important locations in the present program.

7. After the war, according to predictions of aviation specialists, flight strips will serve as landing areas for private and commercial aircraft for many places where the cost of the more conventional and elaborate layouts would not be justified. They will also be desirable as emergency loading fields for the large number of cargo planes that are expected after the war, and as air mail stations for small communities.

8. The present flight strip program under Army Air Forces auspices, is under the direction of a special Flight Strip Division of the Public Roads Administration of which Fred E. Schnepfe is director. Construction is being handled by contracts let and supervised by the state highway departments in accordance with normal federal-aid highway procedure.

Engineering Schools in the War

At a recent conference on wartime problems held at Columbia University, Associate Dean James K. Finch, acting head of the engineering school, reviewed the effect of the war on the engineering school at Columbia and outlined a course that appeared to him to be the most appropriate one for engineering schools to follow. His statement was made on Nov. 13, when lowering the draft age to 18 years appeared probable. Extracts from Dean Finch's talk are given in the following.

IN ANY DISCUSSION of the position of our engineering colleges under war conditions it must first be clearly recognized that radical changes in the past and present position of such colleges are imminent. What we have been and are now doing affords, in all probability, little basis for predicting what we will be doing, say, a year from today. Yet past and present performances demand, at least, some brief attention if we are to understand what is about to happen.

Within a month after Pearl Harbor our School of Engineering at Columbia had formulated an accelerated program of studies to be required for all undergraduate engineering students. We had, in fact, been studying an optional plan for over a year, in anticipation of an increasing demand for technically trained men. We adopted this obligatory acceleration in spite of our conviction that it was educationally undesirable, because we were convinced that modern warfare was simply engineering applied to destruction and that we would need thousands of engineers to make, supply and operate the machinery of war.

Engineers in demand

Early in the year the demand for engineers which we had anticipated began to be felt. We were deluged with applications for men. Industry was speeding up to war production. Engineers were not available in sufficient numbers. Industry offered salaries at increases of two or three hundred percent or more over previous rates. It was difficult to persuade students to complete their course of study for the undergraduate B.S. degree. Graduate enrollment, previously a major element in our engineering work at Columbia, rapidly dwindled to a fraction of its former volume, while undergraduate enrollment, which had increased 25 percent in 1941, again jumped a similar amount in 1942. It was difficult also to hold younger staff members, not primarily because of the draft but because of the insistent demands of government and industry.

Special Courses

To meet this extraordinary demand the U. S. Office of Education encouraged engineering schools to offer non-credit special courses—now known as Engineering, Science and Management War Training (ESMWT) courses—to prepare men and women to shift into war industry's technique from other fields or to aid those in essential industries in stepping into more important positions. All expenses are paid by the federal government and tuition is free. The Naval authorities also stepped into the picture with their recruiting of engineers for the Naval Reserve—the engineering pot was certainly boiling.

> My personal opinion is that young men interested in engineering and having suitable abilities for engineering study should be encouraged to go ahead, make their plans and carry their work as far as conditions permit. I know that our own students prefer to follow our regular liberal program of arts and engineering rather than to undertake a narrowly technical, streamlined abbreviation which will omit all liberal studies and is, in our opinion, educationally unsound.

Draft boards also were directed by Selective Service to defer calling engineering students who could be certified as promising and satisfactory by their schools until they had completed the requirements for their first degree, the B.S. "Engineers are Needed," was the slogan. Our engineering schools, thus, occupied and still occupy a favored position.

During the summer it began to be apparent that this situation was about to change. Engineers are still needed but the military need for manpower seems to have become paramount. We are now advised that the Army and Navy will require every young man who is physically capable of active service.

A notable effect of the new order has been the call by industry for women to replace young men. The demand today, however, is not for women engineers but for women as technical assistants.

Study should be encouraged

What about the young *men* now in these colleges or who may enter in the future?

No complete answer can be given at the present moment. The needs of the Army and Navy are subject to change with the changing fortunes of war. One may, nevertheless, attempt to summarize what appear to be the trends. It seems certain, for example, that, when the new draft law is passed, all young men 18 years old and older who are physically qualified will definitely be called to service. But it also is true that the average entering age of students at Columbia is only 17½ years and it seems certain all college students over 18 years will not be withdrawn at once—the process will require at least months during which time our col-

leges will have an opportunity to adjust their work to the new conditions. My personal opinion is that young men interested in engineering and having suitable abilities for engineering study should be encouraged to go ahead, make their plans and carry their work as far as conditions permit. I know that our own students prefer to follow our regular liberal program of arts and engineering rather than to undertake a narrowly technical, stream-lined abbreviation which will omit all liberal studies and is, in our opinion, educationally unsound.

Colleges still needed

Yet war is war and ideals must be sacrificed to the stern necessities of speedy action. Since the war services cannot handle the preliminary training of all the young men they will call, certainly not in a period of one year, our colleges, arts and engineering, will be called upon to give courses of stream-lined study and training to young men who may be first inducted and then, after examinations, detailed back to these colleges for additional training. Certain requirements in this plan can be anticipated with reasonable accuracy.

In the first place this college training will be given under contract between the college and the government. The students will be under service discipline and the colleges must provide not only instruction but also quarters, food and facilities for some service instruction—and in units for at least 300 to 500 men. It is wasteful of effort to attach the necessary officers to smaller units than that size.

The period of such training will be uncertain—subject to termination as the emergency requires.

The training will be highly technical—basic to the skills required in modern warfare. No time will be available for a liberal education.

Training of this kind will thus be largely engineering training and the burden of instruction will fall largely on the engineering staffs of our educational institutions.

Not engineering education

I must again emphasize that offerings of this kind—either for women or for military needs—are not *engineering education*. They constitute simply brief, high-pressure, highly specialized courses of *technical instruction* essential to the emergency needs of the day.

To summarize, these trends appear to indicate for the future:

1. That a further decrease in the number of graduate students, which has already sharply declined, will probably make it difficult for some engineering colleges to maintain graduate courses.

2. That normal programs of research in our engineering colleges, already largely replaced by war research, will, in the future, be limited solely to war problems. Normal research is being carried on with increasing difficulty both because of priorities on materials and also because graduate students have always been the main source of research manpower.

3. The demand for our regular undergraduate engineering programs leading to the B.S. will probably decline in a year or more to a war minimum.

4. Our engineering schools will be occupied primarily in giving brief, high pressure, highly specialized technical instruction to:

(a) Young men graduates of high schools who will be sent back, after induction, for special pre-combat instruction, and

(b) Young women with one or more years of college preparation in mathematics and physics and destined for employment in the war industries.

5. The ESMWT program will continue but probably as an even more highly specialized, in-industry training than at present—that is, as a series of evening or Saturday courses directed toward the attainment of specific technical skills for special groups of workers in war industries.

6. When the war is over our engineering schools will probably be faced with a major educational problem—that of completing the education of these young people who have been narrowly trained in order that they may most quickly play their part in this conflict. Many of them will want their engineering degrees and many of them will, probably, be engaged in industry and able to study only in the late afternoon or evenings. Schools located in great urban centers, such as Columbia, will thus be called upon to expand their offerings for men in industry—now largely graduate in character—both for men and women who wish to come back to college and establish the fundamentals of a sound, liberal engineering education. This is a type of service to which Columbia will gladly devote her best efforts for it is this type of engineering education—liberal and sound education in the truest sense—to which we have long been dedicated.

Vibration Considered Major Factor In Design of Airplane Runways

Heretofore the careful design of airplane runways has included an impact allowance of 25 or 50 percent of the gross wheel load. In the light of recent tests and studies of this subject, the trend is very decidedly away from such allowances and toward more emphasis on vibration.

Vibration is now a factor in standard design for hardstands, warming-up aprons and for any location where motors of the airplane are operated and resultant vibration is transmitted to "flexible-type" pavement without either (1) forward movement that transfers the load from point to point or (2) the lift, and consequent lessening of wheel load, that occurs when wings move forward rapidly. In such locations, i.e., for static wheel loads that will include vibration, it is now a standard requirement to add 25 percent to gross wheel loads for vibration effect.

Out on the runways themselves there may be either plus or minus departures from normal or "standard" pavement requirements. For example, additions to provide for such conditions as subsoil of low bearing value and subtractions where the runways are quite wide and hence present less likelihood of many load repetitions in exactly the same location. On this latter count new standards permit a 20 percent lower requirement.

Thus, instead of runway pavement being made heavier than warming-up areas, modern design might in some cases decrease the standard requirements by 20 percent for the runways and increase them by 25 percent for the warming-up areas.

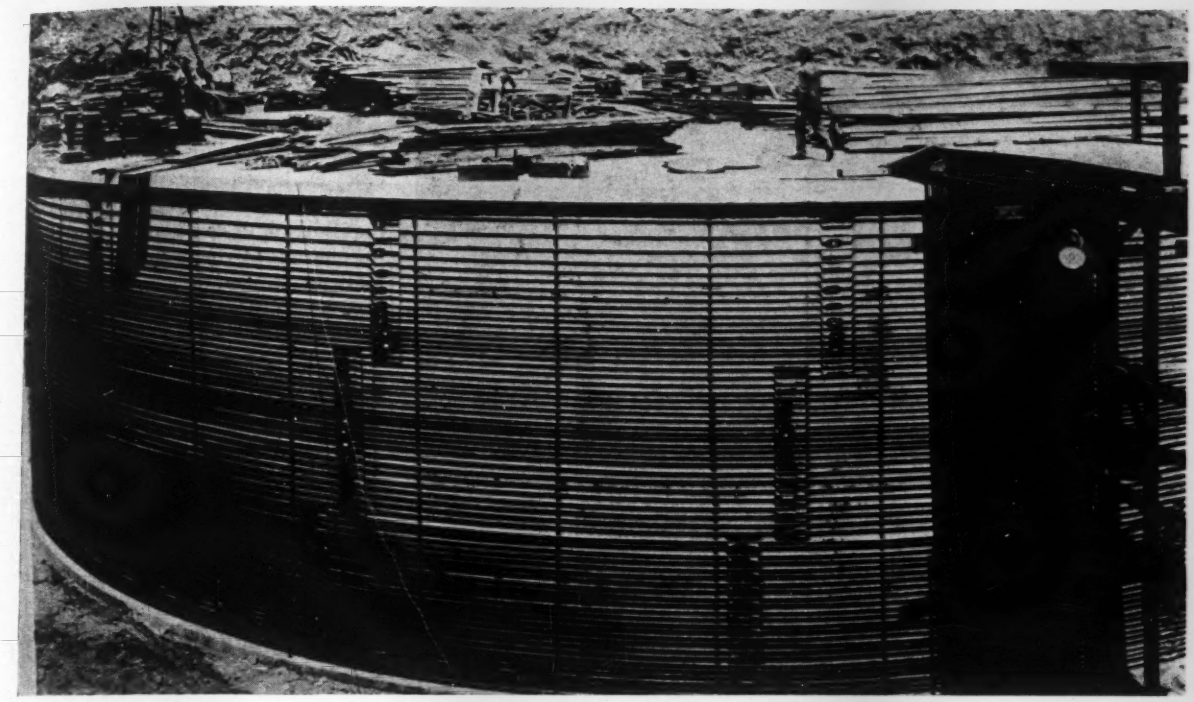


Fig. 1. A 27,000-bbl. tank constructed in a hillside is ready for concrete encasement over prestressed rods.

Navy Builds Prestressed Concrete Tanks

R. B. Garrabrant
Assistant Head, Research and Records Division
Bureau of Yards and Docks, Navy Department

***Contents in Brief**—To store its fuel supplies without using critical steel plates, the Navy is making extensive use of concrete tanks and is using a prestressed design to minimize shrinkage cracks. Construction procedure has been developed to a high state of efficiency. All tanks are buried underground. Iron dust mortar is used in annular joint between wall and floor to save the rubber ordinarily required. Roofs are supported by columns. Various types of linings have been developed to eliminate reactions between the fuel and the concrete, and research is still continuing.*

FUEL IS ESSENTIAL to naval operations, and the amount of fuel storage that must be provided for efficient operation varies both with the numbers of ships and aircraft to be supplied and the extent of the geographical area in which these must operate. As respects the U. S. Navy, the past few months has witnessed an unprecedented expansion in both of these factors, an expansion that will continue until the current war is brought to a satisfactory conclusion. It is obvious, therefore, that the U. S. Navy is necessarily building large numbers of fuel storage tanks.

Until recently the Bureau of Yards and Docks, which has cognizance of the construction of all shore facilities for the Navy, had built only steel tanks for the storage of fuel oil, diesel oil, gasoline, and other liquid fuels. In 1940, however, the possibility was visualized that in time of war adequate quantities of steel plates to meet rapidly expanding needs of the Army and Navy might not be procurable, and the preparation of an alternate design using reinforced concrete was authorized.

Although concrete has certain inherent defects as a material for liquid storage tanks, in that it is porous and readily cracks as the result of shrinkage, temperature changes or foundation settlement, it was felt that these disadvantages could be offset by good design, careful workmanship and the use of suitable linings. Concrete tanks had, in fact, been used successfully for nearly 20 years for the storage of water, petroleum products and other liquids.

Conventional reinforced concrete placed in a form shrinks in setting, thus causing compressive stresses in the steel. Normal design practice uses the steel rods to carry tensile stresses, so that when load is applied a reversal of stress occurs, accompanied by considerable deflection that cracks the concrete. Thus, a concrete tank of conventional reinforced con-

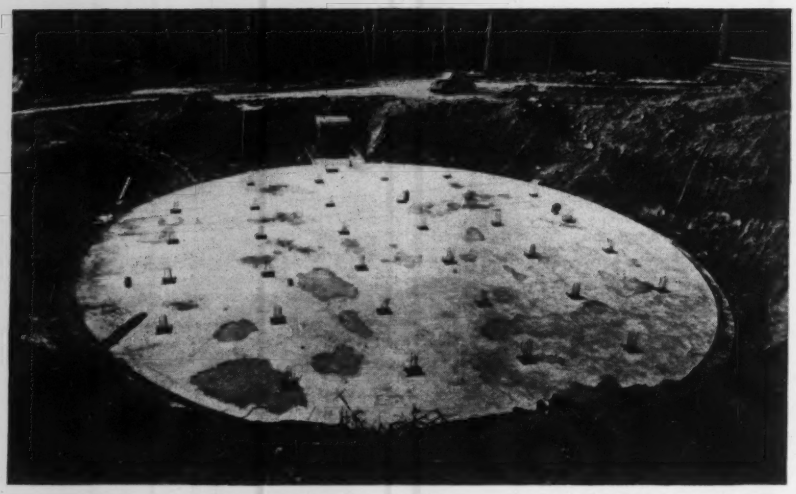


Fig. 2. Base slab for 50,000-bbl. prestressed concrete fuel oil tank. Edge is stepped down to provide a shelf for support of the wall.

crete has many incipient leakage points from the start.

To avoid this condition, the Bureau adopted a design reduced to practice in 1921 by William S. Hewett for the reinforcement of circular concrete structures subject to internal pressure. In essence, this method introduces artificial prestressing that places the concrete in compression and the steel in tension before the load is applied. Its application was first tested by the Navy in the building of a number of 50,000-bbl. fuel oil tanks and 27,000-bbl. diesel oil tanks at Orchard Point, near Seattle, Wash. Construction of these started in July, 1941, and the method proved so successful that standard designs have since been worked out by the Bureau for tanks with capacities of 13,000, 27,000, and 50,000 bbl.; and of 25,000, 50,000, 100,000 and 250,000 gallons. Tanks are being constructed in accordance with these standard designs in very considerable numbers.

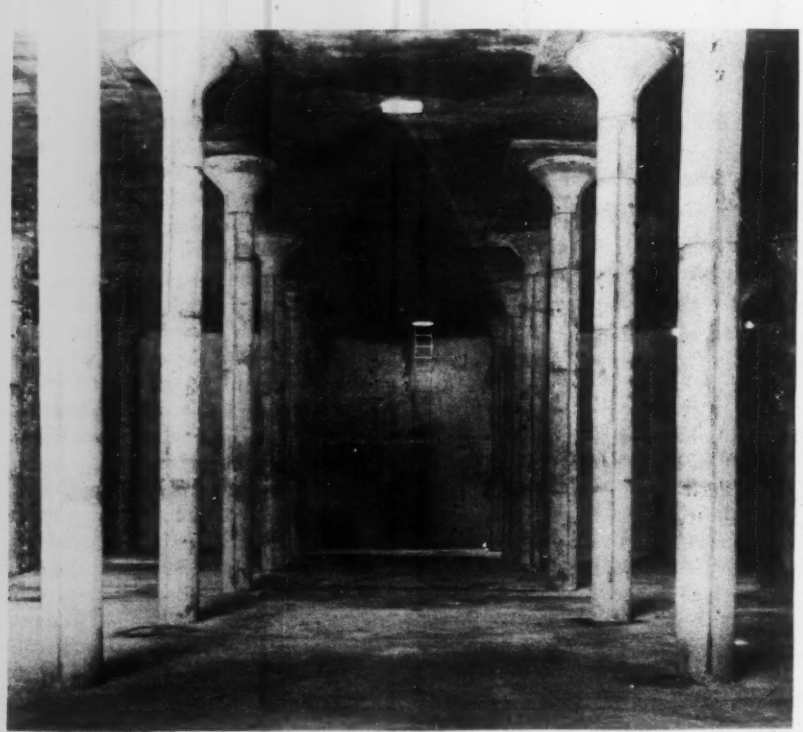


Fig. 3. Interior of completed 50,000-bbl. tank for Navy fuel storage. This is the largest capacity used. All tanks, regardless of size, have column-supported roofs.

Field construction procedure

How the disadvantages of conventional concrete tanks are avoided is best explained by describing the method of construction now used by the Bureau. Current practice calls for the underground concealment of all tanks, so the first steps are excavation, preparation of the subgrade and the installation of piping. The floor slab, with which is combined the wall and column footings, is then laid by conventional methods. Around the circumference of the tank floor the top surface of the slab is stepped down 1 ft. lower than the tank floor proper to provide a shelf for supporting the wall (Fig. 2). This wall bearing area is painted with asphalt to break the bond between the side wall and its footing.

Upon this base the ring wall is constructed in two stages. The first step is to pour the wall to its full height and to about three-quarters of its final thickness, using only temperature reinforcing beneath each surface. Vertical construction joints divide the wall into as many equal sections as are needed to permit casting the full height of the wall in a single pour. At least 36 hr. must elapse between the placing of any two adjacent sections to permit initial shrinkage to take place in the section first poured. To permit circumferential shrinkage, a wedge-shaped annular space from 1 to 1½ in. wide is left between the wall base and floor curb.

The prestressing operation

Not less than 60 hr. after the last wall section is placed the main reinforcing is applied. This is in the form of horizontal circumferential hoops made of specially selected round rods with a yield point of not less than 50,000 psi. Rod sections are threaded and connected by turnbuckles in such a manner that they can be tightened by a downward motion of a lever arm inserted in the turnbuckle.

It is evident that by tightening these exterior hoops the main reinforcing can be placed in tension, and the concrete wall section in compression. Subsequent filling of the tank will superimpose upon these initial stresses a tangential load that will increase the tension in the steel rods and decrease the compression in the

concrete, the effect being distributed between the two materials in the ratio of their moduli of elasticity. In the tank design the amount of pre-stressing is calculated so that, as the full design load is reached by filling the tank, the tensile stress in the reinforcing steel approaches its yield point and the compressive stress in the concrete approaches zero. Thus, the concrete is at no time subject to any tension, and its tendency to crack is reduced to a minimum.

In practice, it has been found that the desired degree of prestressing can be achieved with sufficient accuracy by tightening the turnbuckles until the full weight of a 160-lb. workman, applied without impact at the end of a lever arm of pre-determined length, is no longer enough to move the turnbuckle. This length varies from 12 to 42 in. for the various rod sizes used in the series of standard designs. The tightening process is gone through twice, progressing from the bottom to the top of the tank, with force applied simultaneously to all turnbuckles in a single hoop, and with at least one workman between each two turnbuckles to tap the bands with a nailing hammer and thus avoid localized stress.

Sealing wall-base joint

At the start of the band-tightening process, when the four bottom hoops have been brought to approximately half stress, the annular joint between the base of the side wall and the tank floor is packed with iron dust mortar, which is allowed to set for 24 hr. before continuing with the assembly and tightening of the bands. The original Hewitt design called for a flexible gasket in this joint to compensate for expansion and contraction due to temperature changes. The Navy tanks, however, are buried well underground where temperature conditions are fairly stable. For this reason, and to conserve the use of rubber or a synthetic substitute, the iron cement joint filler was adopted for standard designs, and has been found satisfactory in practice. Vertical construction joints and form spacer cone holes are filled with the same material.

After all main reinforcing bands have been fully pre-stressed the steel and concrete for the columns and roof slab are placed. Then the side wall is built up to full section using either cast-in-place concrete 4 in. thick or by applying a 1½-in. layer of shotcrete over wire mesh covering the hoops.

Special linings developed

While the prestressed concrete tank construction results in a minimum of cracking, concrete is inherently a porous material and some form of lining is considered essential to avoid penetration of the tank walls and floors. This is particularly important when the fuel to be stored is high-test aviation gasoline containing aromatic admixtures of toluene, xylene and benzol, which have a tendency to react with the free alkali always present in concrete, with deleterious effects upon the quality of the fuel.

Essential characteristics of a tank lining are (1) resistance to deterioration under long-time exposure to fuel oil, diesel oil, gasoline, or water (the latter always accumulates in the tank bottom); (2) no contamination of the fuel stored; (3) no deleterious effects upon the concrete of the tank structure. Other factors to consider in choosing a lining material include availability in large quantities, use of the minimum amount of critical materials, sufficient elasticity to bridge small cracks, ease of application and low cost.

Extensive experimentation with both new and old materials has resulted in the approval of several types of lining. For fuel oil, an entirely satisfactory coating is provided by four coats of sodium silicate applied with mops, hair brooms or a suitable spray. For diesel oil the Bureau is using an inert resin base enamel applied over a prime coat and covered with a double seal coat, all applied with a spray gun. The storage of high-test aviation gasolines containing aromatics is a more difficult problem, as the admixtures used are, in themselves, strong solvents that attack many materials otherwise resistant to gasoline and to water. The resin-base enamel used for diesel oil offers one fairly satisfactory solution; another is an organic polysulfide film applied by spray or in prefabricated sheets. Both of these are being used, but the large quantities involved, coupled with the fact that the polysulfide material is a form of synthetic rubber for which there are many other uses, has prompted the Navy to continue its research on linings in the hope of developing alternative materials.

Navy fuel storage must normally be located in waterfront areas; therefore, the construction of large tanks involves many difficult foundation problems. The standard design described can be "floated" on soft ground or, if necessary, be adapted to other types of support. Because of the wide variation in conditions encountered no attempt is made herein to give this problem more specific treatment. Each installation is a problem in itself.

As has been noted, the Navy's standard designs for pre-stressed concrete fuel tanks are based primarily on principles evolved by William S. Hewett. Detailed plans and specifications have been prepared by the personnel of the Bureau of Yards and Docks, of which Rear Admiral Ben Moreell (CEC), USN, is chief.

High-Early-Strength Cement Concretes

Ten-year compressive-strength tests have now been completed on concretes made with twelve high-early-strength cements. The concretes were of three different cement-water (C/W) ratios, five initial temperature conditions, and four curing conditions.

As reported by L. Schuman in the Journal of Research (RP1508), concretes stored in damp air generally continued to gain strength up to 10 years. Concretes stored in the air of the laboratory had about the same strengths at 10 years as at 28 days. The strengths at ages after 28 days were not appreciably affected by the initial temperatures, which varied from 70° to 110° F. However, the usual variation in strength with C/W ratio persisted up to 10 years. For damp-cured 1:2:4 concrete of C/W ratio = 1.50 (7.5 gal. water per 94 lb. bag cement) the compressive strengths at 10 years were generally between 4,000 and 5,000 lb/in². For concrete of the same proportions, and a C/W ratio of 1.73 (6.5 gal. per bag), strengths of over 6,000 lb/in² were attained for 8 of the 12 cements tested.

Present-day cements, even of the moderate-heat type, are shown to be capable of giving concrete strengths in 1 month at least equal to those for a 1910 cement at 10 years; present-day (1941) high-early-strength cements may give strengths at 1 month exceeding the 10-year strengths reported in this paper.

Contact Aeration for Sewage Treatment

Llewellyn B. Griffith
Consulting Engineer and Vice-President
Hays Process Co., Austin, Tex.

***Editor's Note**—With 74 plants in twelve states now being built or in operation, the Hays submerged contact aeration process assumes a place of considerable importance in the field of American sewage treatment. Most of the plants have been built within the last 18 months, many being located at military establishments; they vary in size from 500 to 40,000 population capacity. Acting on the invitation of Engineering News-Record, Mr. Griffith, who is associated with Mr. Hays, the inventor of the process, outlines latest design practice and operating experiences.*

BEGINNING WITH STUDIES of stream pollution, Clyde Hays, city chemist of Waco, Tex., conducted bacteriological experiments in 1930 that indicated new possibilities for sewage treatment by application of the known purification processes in natural streams. By use of a series of specially designed contact aerators and settling units, successive stages in the purification of dirty water were identified by the organisms known principally to be responsible for these various steps in the purification of a natural water course.

Groups of aerobic organisms were classified with reference to their work as the:

(1) Dirty and semi-dirty water group (*polysaprobic* and *A-mesosaprobic* organisms, an example of which would be the *Beggiatoa alba*.) These organisms form a gelatinous slime mat on suitable contact surfaces and give rise to large numbers of whitish-gray filamentous forms that produce enzymes capable of coagulating and precipitating the colloids in domestic sewage. The *polysaprobic* group is found where oxygen is lacking and much degradation exists; whereas the *A-mesosaprobic* group is present where the oxidation phenomena begins and there is a trend towards mineralization. The absence of these organisms where purification has progressed is significant.

(2) Semi-clean and clean water group—(*B-mesosaprobic* and *oligosaprobic* organisms). The diatom *Navicula* is one of this group and is

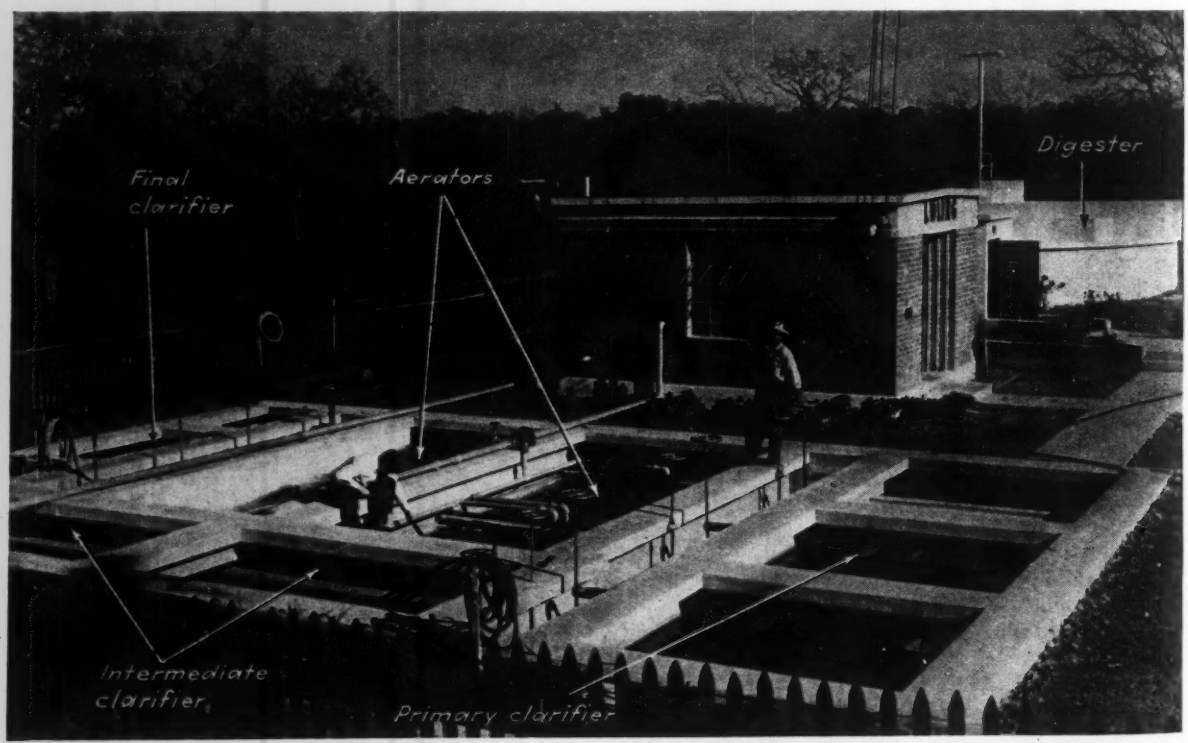


Fig. 1. Compactness of a Hays process plant is shown by this installation at Luling, Tex. Providing complete treatment, the plant has a capacity of 250,000 gals. L. B. Griffith, author of this article, is seated on an aerator tank making adjustments with the aid of a Mexican plant operator.

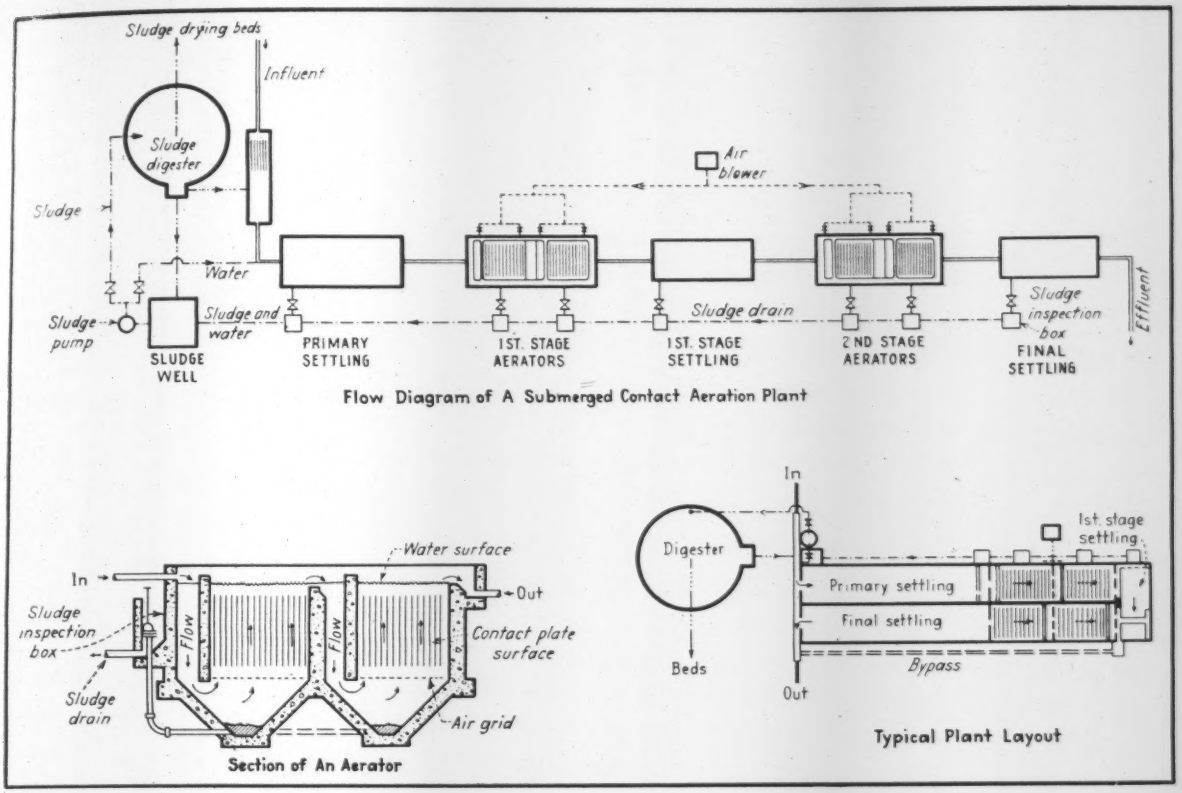


Fig. 2. Processing units and flow diagram for a Hays submerged contact aeration type of sewage treatment plant. Settled sewage is passed through a dual-compartment aerator, permitted to settle again, and then flows to a second dual-compartment aerator after which it receives final sedimentation. The aeration tanks, which are hopper-bottomed for sludge collection, contain vertical contact plates spaced closely together.

usually found only in cleaner waters. These organisms form brownish-green slimes which assist in nitrifying and oxidizing ammonia to nitrites and nitrates. The *B-mesosaprobic* group is found where conditions of purification are becoming stabilized and oxidation and mineralization are producing a more stable, non-putrescible liquid. The *oligosaprobic* group are present where there is an abundance of dissolved oxygen and where a high degree of purification is already accomplished.

(3) Among both of the above groups, certain aerobes exist that convert unstable organic material in sewage to mineral matter, relatively odorless gases and settleable organic products of sludge.

The idea of successive stages of filtration and aeration had long been known in stream purification practice, but as applied in the Hays process of sewage treatment it results in a condition that differs radically from that obtaining in activated sludge or coarse-grained filter processes. In the former the floc must support organisms of many kinds in close proximity, while in the various coarse-grained filters the nitrifying organisms, which require appreciable amounts of oxygen, are relegated to the bottom of the filter where the oxygen supply is apt to be insufficient.

It also differs from early types of contact aerators, "colloiders" and "nidus racks" in successfully combining adequate contact surface, continuous unloading facilities, more complete oxygenation and scrubbing action by aeration and provision of multiple aerators and settling compartments for successive steps of purification. The process may, in fact, be thought of as a self-purifying stream longitudinally compressed into a compact series of treatment units.

History of development

Hay's experiments resulted in the construction of a pilot plant at Waco, Texas, which treated 40,000 gallons daily. In 1938, when the experiments had reached a stage that pointed to possible application in sewage works engineering, the Hays Process Co. was formed and mechanical improvements and design criteria were worked out that were acceptable to the Texas State Department of Health for use in small cities.

Suitable two-compartment units were developed to provide the successive stages of aeration and settling which would permit the many groups of sewage organisms (more than thirty groups have been identified) to select and function in the environment best suited to their growth. In this way certain forms of organic matter are removed in the first compartment and, since these substances do not pass into the second compartment, they cannot inhibit the growth of subsequent groups of organisms.

The first municipal plant was built at Elgin, Tex., in the spring of 1939. This plant is designed for 1,230 connected population. To date, all tests made under normal operating conditions have shown a reduction in 5-day B.O.D. of approximately 95 percent. A B.O.D. "shock" test for a two-hour period, made by the Texas A. & M. research laboratory at College Station, which involved a B.O.D. over-

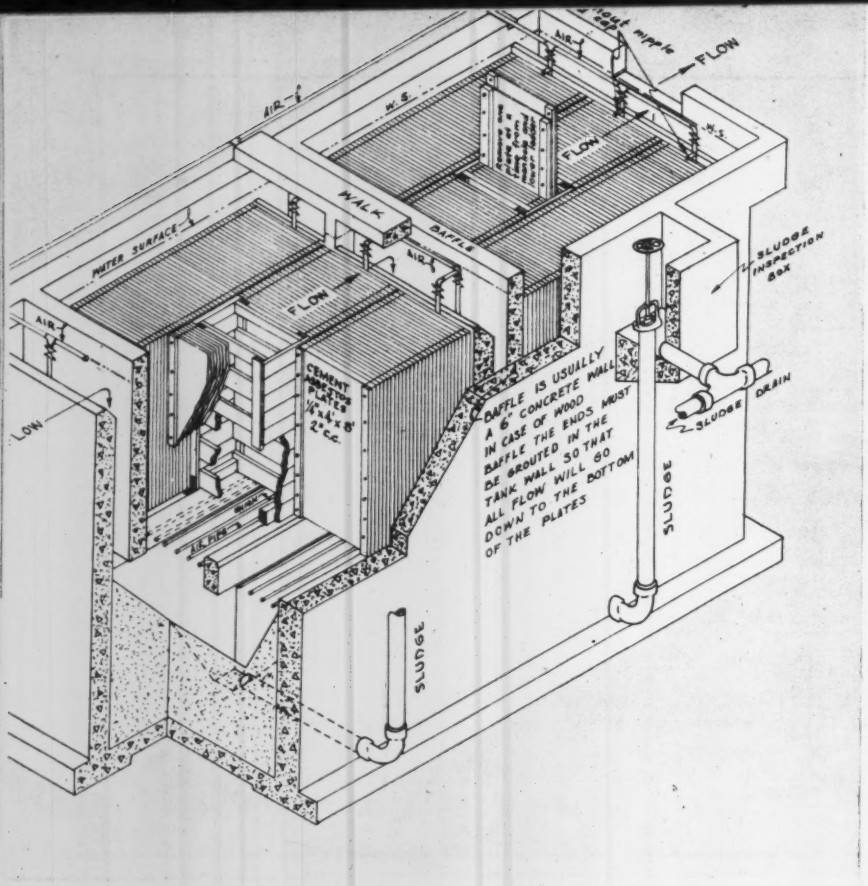

FLOW
AIR
WATER SURFACE
WALK
BAFFLE
SLUDGE INSPECTION BOX
CEMENT ASBESTOS PLATES ¼" x 4' x 8' 2" c.c.
BAFFLE IS USUALLY A 6" CONCRETE WALL IN CASE OF WOOD BAFFLE THE ENDS MUST BE GROUTED IN THE TANK WALL SO THAT ALL FLOW WILL GO DOWN TO THE BOTTOM OF THE PLATES
SLUDGE DRAIN
SLUDGE
LOW

Fig. 3. Aerator tank construction and assembly. Two separate compartments, each filled with cement-asbestos plates, are provided. Flow is directed upward, from the bottom to the top of the plates. Air is supplied through a perforated pipe grid above which the contact plates are supported.

load of more than 500 percent, showed a reduction of 91 percent. During August, September, and October of 1939 laboratory tests were made by the Texas State Department of Health at the Elgin plant, and the average results shown in Table I were obtained.

Individual tests showed all B.O.D. and suspended solids removals were between 94 and 98 percent. The only operator was inexperienced in sewage treatment, and averaged two hours attendance both in the morning and afternoon. This type of operation, of course, would be inadequate for larger plants.

While the Hays Process Co., in collaboration with the Texas State Department of Health and technicians of other laboratories, has kept performance records for a number of plants it has not been possible since the start of the war to conduct many tests due to the lack of laboratory equipment and other restrictions. In addition, a considerable amount of operating data at Army establishments has been collected, but this data will not be available to the profession until after the war.

Some data on design

Basic design developed by the company for municipal sewage is the result of analysis of plants in operation under normal operating conditions and interpretation of previous data collected by Hays at the small pilot unit in Waco.

It is important to note that the basic design for settling units and aerators is based upon the flow and strength of the sewage for average conditions during the three continuous hours of maximum conditions. Because of the tendency in present practice to base design on daily average B.O.D. conditions rather than on the average maximum three-hour condition a "design rate factor" is used, which is a ratio of the average hourly B.O.D. load during the maximum three-hour period to the average hourly B.O.D. load for twenty-four hours. This factor varies over a wide range and has reached 300 percent where unusual loads exist for three to six hours daily.

Hydraulic design, including flow in channels takes into consideration probable ultimate short period peaks, and "slugging" from excessive periodic flows of over-designed raw sewage lift pumps. Such "slugging" has been observed to reduce the detention period to one quarter the average required time for settling, as well as to cause the delivery of organic matter at four times the daily design rate.

A typical plant provides in sequence, screening, primary settling, first-stage submerged contact aeration in tandem units, intermediate settling, second-stage submerged contact aeration in tandem units, and a tank for final settling. Settling units are of conventional design and provide detention periods as shown in Table II; an assumption is made that the estimated average flow during the worst three continuous hours is 150 percent of the daily average.

The adequacy of these settling periods is due, perhaps to the fact that each aerator is also a highly efficient settling unit with or without aeration (or biological functioning). Observation shows that under normal operation there is progressive oxidation, flocculation and increase of settling velocity of solids throughout the entire plant as the sewage composition becomes more stabilized and homogeneous.

In each stage the submerged contact aerators are similar, consisting of two identical compartments in series. In

TABLE 1—OPERATING DATA FROM THE HAYS PROCESS PLANT AT ELGIN, TEX.

(Average of daily weighted composite samples, 6AM to 5PM. No chemicals used. 968 connected population)

	Sus. Solids	*B.O.D.*	*D.O.*	*NO_3*
Raw influent—ppm.	106	140	0	0.3
Primary settled effluent—ppm.	36	63	0	0.3
First stage effluent—ppm.	5	31.3	3.9	15.0
Second stage effluent—ppm.	2	5.6	6.5	37.0
Overall removal in percent.	98	96	—	—

Air consumption averaged 0.33 cu.ft. of air per min. for each square foot of aerated water surface against a total head of 4 lb. per sq. in. Contact media consists of fieldstone, from 2 to 6 in. in diameter.

each compartment the influent usually passes down a baffled portion of the tank to the space below the contact media. The flow then is uniformly upward between the contact media, which may be rock, concrete cylinders, metal plates or other suitable surface material.

From the standpoint of mechanical adaptability and cost the best contact media appears to be flat asbestos-cement plates set vertically and at right angles to the tank axis. These sheets of ¼ in. thickness, are placed 1½ to 2½-in. c.c., and extend from six inches above the air piping to within four inches of the aerated water surface. Each plate usually has wooden spacer strips nailed in a vertical position to the plates. Flow from the first aerator compartment passes over a weir into the baffled portion of the second compartment where the conditions are identical.

An important mechanical advantage of this type of aerator is that it eliminates short-circuiting. Without air, or with an even distribution of air, the flow between any two plates appears to be the same due to equal resistance to flow.

Given adequate aeration in this type of aerator the slimes are given a most favorable environment and can unload continuously either downward or upward. This explains the fact that complete treatment has been accomplished where the total aeration period is only from 1½ to 2½ hr. under average daily flow conditions for the sewage of a typical community. On the other hand inadequate aeration may frequently result in excessive growths of fungus which has to be removed occasionally by a water jet, a wooden strip or increased agitation with air.

Air requirements

Since the biological treatment in the aerators is a surface phenomenon within the range of plate spacing of 1½ to 2½-in., the B.O.D. reduction per hour is a function, therefore, of the contact surface, provided there is an adequate supply and distribution of air to the biological film from bottom to top of the plates. From analyses of plants treating municipal sewage the rate of reduction has been found to be about 0.0508 lb. of B.O.D. per hour for each 100 sq.ft. of contact surface. Therefore, basic design requirements call for 82 sq.ft. of contact surface for every pound of B.O.D. per day loading on the aerators at a uniform rate.

TABLE II—SETTLING TANK DETENTION PERIODS

	At design flow	Design rate factor	At average daily flow
Primary	1.00 hr.	150%	1.50 hr.
Intermediate	0.75		1.12
Final	0.50		0.75
	2.25		3.37

If the B.O.D. load rate during the average worst three-hour period were estimated to be 150 percent of the daily average rate, the design would be based upon 82x150, or 123 sq.ft. of contact surface required for each pound of B.O.D. delivered to the aerators daily. For example, if the total B.O.D. per day were 167 lb., and the primary settling tank removed 40 percent, the load on the aerators would be 100 lb. per day, requiring in this case 12,300 sq.ft. of contact surface; since a single plate has two sides there would be needed 6,150 sq.ft. of asbestos-cement sheets. For typical domestic sewage there would be 3,075 sq.ft. of contact surface in each of the dual compartment aerators provided by the first and second stage units.

The design of Hays process plants anticipates occasional short period B.O.D. peaks of several hundred percent of the design peak rate without upset. However, continued B.O.D. "slugging" from lift pumps, which deliver sewage at excessive rates during short intervals throughout the day, will produce the expected result of decreased biological action by extending the growth of the first-stage zone of dirty water organisms into the second-stage unit virtually producing nothing more than single-stage treatment. Similar effects of B.O.D. "slugging" also occurs in small plants from the return, at excessive rates, of concentrated septic and toxic wastes from a poorly operated digester. Biological recovery and readjustment of the process occurs quite rapidly, however.

The air supply system for the contact aerators is designed to give an even distribution of air between all the plates, with the aerated water surface above the plates showing a uniform distribution of medium-size bubbles. This assists in maintaining uniformity of vertical flow of aerated liquid between all the plates as well as aiding in the continuous unloading of biological growths. A properly designed air grid will give adequate

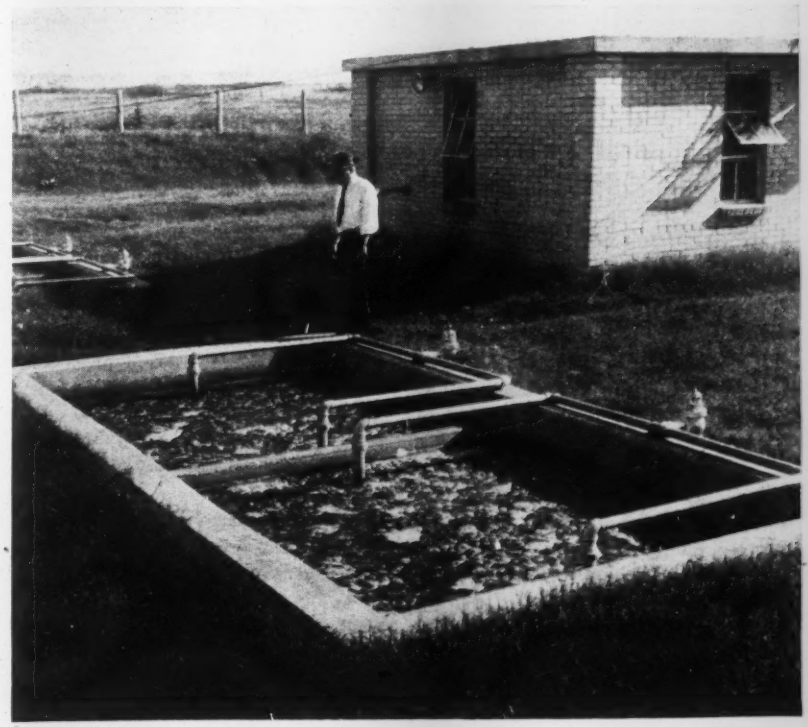


Fig. 4. First-stage aerator in operation at Elgin, Tex. This was the first municipal sewage disposal plant to employ the Hays treatment process.

aeration with about 0.33 cu.ft. of free air per minute for each square foot of aerated water surface. Should the plant be underloaded, all the biological stages may arrange themselves in the first-stage compartments from bottom to top, making it unnecessary to use any air in the second-stage aerators. Power consumption for air is a function of the depth of the plates and the distribution grid, the required pressure being about 4½ lb. per sq.in.

Arrangements are provided so that sludge from all settling and aeration units is usually drawn by visual means and flows by gravity to a central well from which it is pumped to the digester. Digestion tank capacity is about the same as that for trickling filter plants. Since it is mechanically necessary to draw off a large amount of water with the solids from the second stage, it is sometimes found advisable to first settle this sludge in the well and pump only concentrated material to the digester. The remaining liquid can be returned to the raw sewage.

In this process no sewage or sludge need be recirculated. Normally the supernatant liquor from the digester and the drainage from the sludge drying beds is discharged untreated into the raw sewage. If the digestion process becomes upset the supernatant may be discharged gradually into the plant influent or discharged to the sludge well for liming. By liming, most of solids and toxic sulphides are readily precipitated for return to the digester. In this way only the relatively weak liquid need be discharged into the raw sewage.

Operating experiences

Based on studies at the initial plants installed at Elgin, McGregor, and Garland, Tex., the Army, Navy, federal housing agencies and a number of cities have built more than sixty Hays process plants during the past 18 months. These plants serve populations ranging in size from 500 to 40,000. Although all these plants adhere to the basic design data established by the engineers of the Hays Process Co., they reflect the individuality of the engineers who made the final design, as a result of which the mechanical details vary widely.

Relatively few difficulties have been experienced that have not been common to other types of sewage treatment. However, because of the wide interest shown in this unfamiliar type of treatment there has been much controversy as to design details, and in some instances this has been interpreted in an adverse manner. The larger plants presented many mechanical problems that were to be expected due to the fact that the process was new and the designs had to be developed under the pressure of military exigencies. Some difficulty was encountered because operators were unacquainted with this type of treatment, a situation that has been largely overcome by training and actual operating experience.

A few plants have encountered trouble from "slugging" by raw sewage pumps; however, such difficulties also have been experienced with other treatment processes that have been developed under similar circumstances. By far the most serious difficulties have arisen, chiefly as a result of poor air distribution. Since the success of this process is dependent absolutely upon adequate aeration to the contact surfaces, recent designs have provided more efficient air grids: the latter are accessible for repairs through a manhole, which can be entered by removing a few contact plates. Another successful type of grid provides short, tee-shaped pipes, suspended between contact plates so as to form a system of perforated grids under the plates and parallel to the direction of flow. Grids are spaced 8 to 12 in. apart, with ⅛-in. holes underneath the pipes and spaced from 2½ to 4 in. along the pipes. This arrangement permits the removal of individual grids for examination and servicing. Studies are underway which show promise of greatly improved efficiencies in air distribution with a minimum of installation and maintenance cost.

In evaluating the Hays process of submerged biological contact aeration as a method of sewage treatment it should be mentioned that, all things considered and based upon studies of many of the 74 plants being built or operated in twelve states, this type of treatment has in many cases been shown capable of producing highly satisfactory results and does have some unique advantages. Some of the features of a satisfactorily operating plant are:

(1) An overloaded unit does not "go out" quickly—it merely spreads the first zone of coagulation through the plant, resulting in a one-stage treatment. In the case of an underloaded plant the organisms may crowd into the first stage of aeration where all of the zones of purification will arrange themselves.

(2) Since in this treatment the flow, as in a natural stream, is continuous through the plant, successful operation is not dependent upon complicated recirculation of sewage or sludge.

(3) Each unit, including aeration tanks, serves as a settling unit.

(4) Reduced short-circuiting within the aerators assures that every square foot of contact surface will be biologically effective.

(5) Practically no clogging occurs because of continuous unloading and air scrubbing.

(6) For small plants the operation is simple, and some plants have been operated by an untrained operator with only four hours attention a day. Large plants have considerable mechanical equipment and require continuous and more skilled operation.

(7) No nuisance results from odor or filter flies.

(8) The degree of treatment is comparable with the best types of processes used today, and tests have shown the effluent to be very high in nitrates, indicating complete oxidation.

(9) The plant can be built as a one-stage treatment if 80 to 90 percent reduction is adequate. This results in considerable saving in first cost and operation.

(10) Loss of head through small plants can be only 6 in. to 2 ft.

(11) Total detention period for complete two-stage treatment of typical municipal sewage is about four hours for average three-hour maximum flow rate, or six hours for average flow. Therefore, a compact and economical design can be made. Furthermore, the aerator depth can be adjusted to meet foundation conditions by using any desired plate depth between 4 and 8 ft.

(12) In typical plants approximately 0.9 cu.ft. of air per gallon treated is adequate against a total pressure of only 4½-lb. per sq.in., which costs about 33 percent less than the same amount of air at a pressure of 7 lb. per sq.in. usually required in activated sludge plants. Recent designs of air distribution systems have tended to increase the aeration efficiency an appreciable amount.

Timber Tower for 50,000-Gal. Tank

RUSH CONSTRUCTION of military training camps, reception centers, embarkation depots, etc. often requires water supply systems that must be built with materials quickly available, preferably using as little as possible of those in the "critical" classification.

Water supplies are usually among the more important items, and frequently towers are needed for elevated tanks. Where timber can be had locally it is, on several counts, the preferred material for emergency construction.

Detail design data

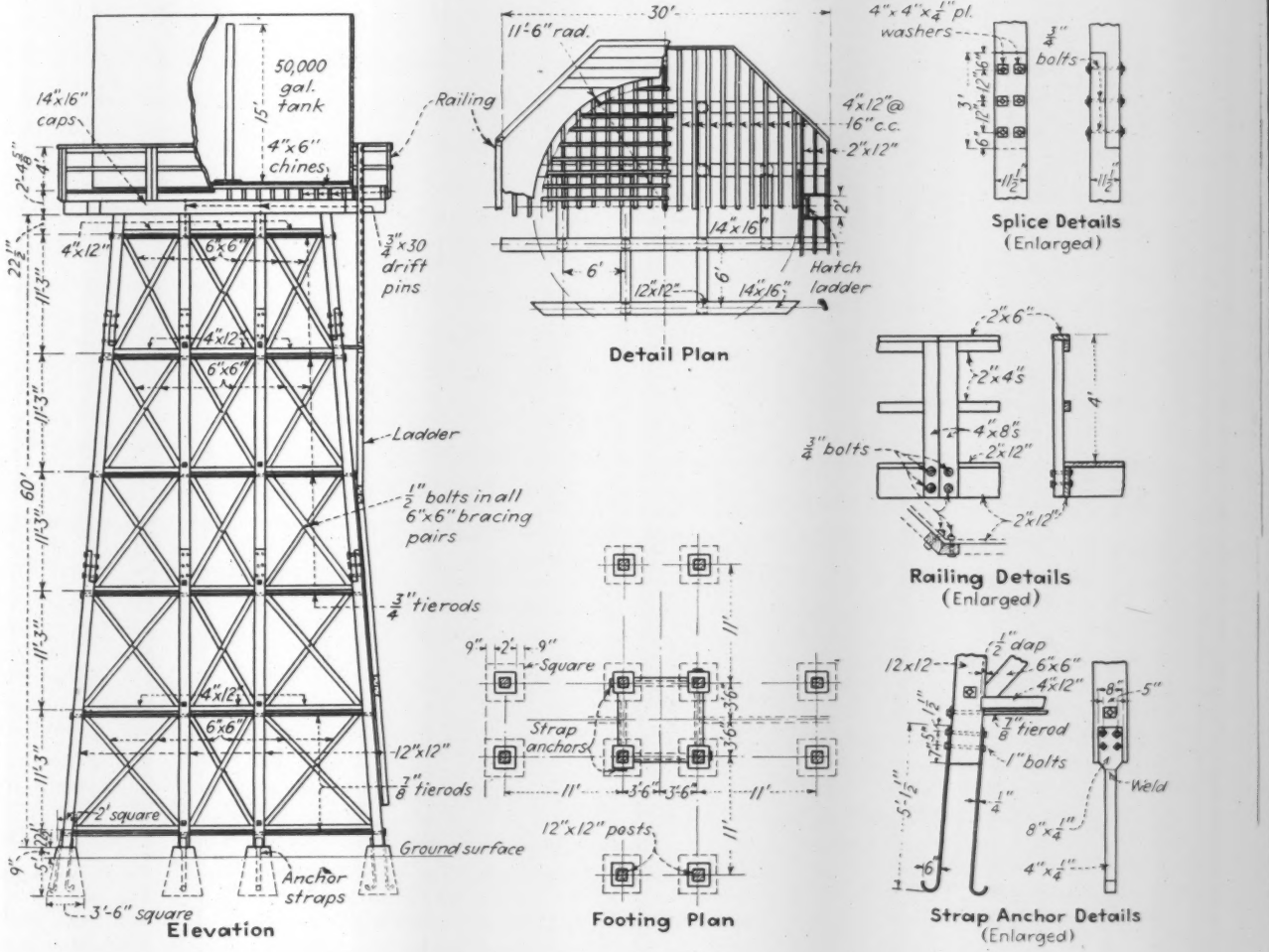
Details of the timber tower shown in the accompanying drawing are published to put on record data that may be useful in planning other structures of this sort.

At a military encampment in the Pacific Northwest, a water tank of 50,000-gal. capacity was required on short notice that had to be supported at a height of 60 ft. above the ground. Timber was available from nearby mills and a substantial tower design was worked out using 12x12-in. timbers for the main members which were well anchored to concrete pier foundations.

This type of construction is well understood by "rough carpenters" of the lumber regions and lends itself readily to a convenient method of erection. The several bents are framed on the ground in locations suitable for erection in speedy succession, and are usually pulled up into vertical position by a tractor with the aid of a line passing over a sheave on a gin pole, A-frame or some part of the structure already in place. As the bents are pulled up, guy ropes are used to support them until they can be braced in place.

Tank assembly method

The wood stave tank comes to the job precut but knocked down. Staves and bands are hoisted to the tower top and assembly is thus made in final position.



Principal dimensions and spacings for a 60-ft. high timber tower to support a 50,000 gal. water tank.

Flexible Pavement Design Discussion Features Highway Research Meeting

***Contents in Brief**—Questions raised by the heavy wheel loads to which flexible pavements are now subjected were the chief center of interest at the 22nd annual meeting of the Highway Research Board. Other subjects considered were soil stabilization and concrete durability.*

CHIEF INTEREST at the 22nd annual meeting of the Highway Research Board of the National Research Council, centered in the design of flexible pavement, new questions having been raised by attempts to design economical pavements for airport runways subjected to the heavy wheel loads of modern combat planes. The meeting was held in St. Louis, Dec. 1-4, as reported briefly in *ENR* Dec. 10, p. 817, and Jan. 14, p. 71.

The session on design opened with a paper by O. J. Porter, California Division of Highways, on foundations for flexible pavements. Mr. Porter stated that measurement of the action of flexible pavements under static and moving loads suggests that the stress transmitted to the subgrade may exceed the strength of the soil without causing failure, provided the load does not remain for a sufficient length of time to displace the subgrade or subsoil. Also, failure does not occur unless the load transmitted to the subgrade exceeds the strength of the soil in an amount sufficient to progressively deform and ultimately shear the base and pavement. Hence, measurement of pavement deflections under static and dynamic loads offers the best method for determining the adequacy of foundations. The permissible deflection depends on the flexibility of the pavement, type of deformation (elastic or permanent) radius of curvature of deformation and the number of repetitions.

Mr. Porter said that a few million repetitions were found necessary to cause failure on some types of pavements where the deflection was only 0.02 or 0.03 in., while serious failure developed rapidly where the deflection was around 0.05 in.

Design methods based on the bearing-ratio test method devised in California in 1929 were outlined by Mr. Porter and he showed curves tentatively adopted by the department for use in the design of airfield runways. These he said need to be checked by field experience.

Dynamic loads on runways

Many good grades of sandy soil become "quick" and displace under the action of airplane wheel loads and the vibration of airplane motors, Mr. Porter said, unless they are thoroughly compacted to a depth of at least one and one-half times the width of the loaded area. This will not occur in moderately compacted sandy soils if groundwater is low and the material does not become completely saturated. Hence, good drainage reduces the need for high compaction in sandy soils. Clay soils, on the other hand, become plastic under impervious pavements regardless of initial compaction and drainage conditions. As a consequence, Mr. Porter said that the thickness of pavements should be increased 10 to 20 percent under taxiways and under the central portion of runways where the maximum number of wheel loads occur together with motor vibration.

Vibration of motors during taxiing and take-off may increase the pavement deflection from 20 to 100 percent. Even where soils do not become "quick", vibration may increase the rate and amount of deflection.

Army runway studies

Flexible pavement design studies being conducted by the U. S. Engineer Department were described by T. A. Middlebrooks of that department in a paper prepared jointly with Capt. George E. Bertram of the Air Force, U. S. Army. Mr. Middlebrooks said that after comparing the California bearing-ratio test method with field bearing test methods under study by the department it was decided that the time had come to stop theorizing and adopt the empirical California method for design of flexible pavements. With the assistance of Arthur Casagrande of Harvard University and O. J. Porter of the California Highway Department, the office of the Chief of Engineers extrapolated the California highway experience for wheel loads up to and including 75,000 lb. and then checked the resulting curves by a traffic test on specially constructed test sections and on existing airfield pavements before turning them over to the field forces. Since that time, experience on airfields has shown that the thicknesses called for by these curves are too conservative for cohesionless soils such as sand. Therefore, the curves will be modified as soon as sufficient data are available to indicate what the changes should be.

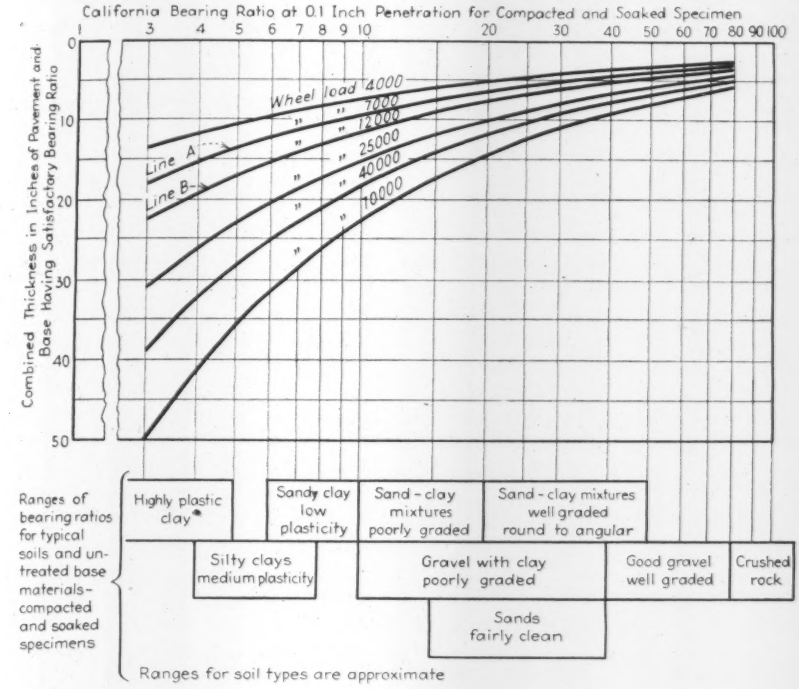
The results of these investigations were checked against Westergaard's formula for the design of concrete pavements and the results compared so favorably as to result in the adoption by the Army of that method for the design of rigid pavements, employing the field bearing test for determining the modulus of soil reaction and using that value in Westergaard's center loading formula. It is anticipated that changes in methods will be made as more elaborate studies presently to be conducted at the Vicksburg laboratory provide answers to questions that remain open.

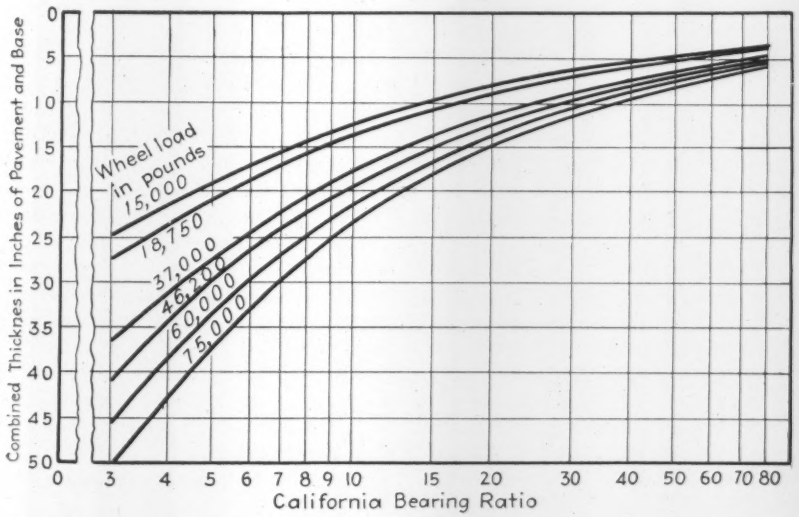
In the design methods now used by the Army, the impact factor is omitted when designing runways and the static load is increased 25 percent in designing taxiways, aprons and turnarounds.

Studies on concrete pavement are being conducted by the Ohio River Division of the U. S. Engineer Department.

A method for designing flexible pavements to insure a sufficiently wide distribution of wheel-load pressures to prevent the subgrade from

deforming in a manner that will cause unsafe stress in the subgrade was presented by M. G. Spangler, Iowa Engineering Experiment Station. It is based on assumptions that the resistance to deformation supplied by a flexible pavement is negligible; that the subgrade soil becomes quasi-elastic in character and that its deformations may be calculated by the theory of elasticity if proper deformation constants are utilized; that the horizontal pattern of vertical pressure on the subgrade is circular in shape and the stress surface is a surface of rotation about the vertical axis through the load. Mr. Spangler admits that the first assumption is not strictly in accordance with fact, also that the second needs to be qualified by the statement that soils are not elastic in the sense that they will rebound or recover all deformation when the applied load is removed.


California Bearing Ratio at 0.1 Inch Penetration for Compacted and Soaked Specimen
Combined Thickness in Inches of Pavement and Base Having Satisfactory Bearing Ratio
Wheel load 4000
" " 7000
" " 12000
" " 25000
" " 40000
" " 10000
Line A
Line B
Ranges of bearing ratios for typical soils and untreated base materials—compacted and soaked specimens
Highly plastic clay
Sandy clay low plasticity
Sand - clay mixtures poorly graded
Sand - clay mixtures well graded round to angular
Silty clays medium plasticity
Gravel with clay poorly graded
Good gravel well graded
Crushed rock
Sands fairly clean
Ranges for soil types are approximate



Tentative design charts for flexible runway pavements developed by the Corps of Engineers from extensive studies made by the California Division of Highways. Lines A and B (upper chart) are from California experience with light highway traffic and medium heavy traffic, respectively. The lower chart is for loads commonly used in runway design studies.

Prevost Hubbard of the Asphalt Institute, took exception to Mr. Spangler's assumption that the subgrade acts as the sole supporting medium for the pavement and that resistance to deformation supplied by the pavement itself is negligible, adding in passing that the same assumption appears to have been made by some of the earlier speakers. Mr. Hubbard said that tests made by the institute according to methods reported in the 1940 *Proceedings* of the Highway Research Board, p. 271, showed that hot-mix, dense-graded asphaltic concrete has a very material resistance to deformation. Except in the case of soils of very low bearing value, a 6-in. asphaltic concrete shows more than twice the resistance of that is developed by a 6-in. layer of crushed rock for the same deflection under load. Hence, if 10 in. of mechanically stabilized mineral aggregate should be called for to afford the necessary support, the substitution of 3 in. of asphaltic concrete for the surface of the pavement would make it possible to reduce the thickness of mineral aggregate under the pavement from 7 to 4 in. This is not true of asphalt mixes other than densely graded asphaltic concrete, Mr. Hubbard said.

Support to Mr. Hubbard's view was given by Harry G. Nevitt, Socony-Vacuum Oil Co., who said that high-type bituminous surfacing does provide a very definite beam action which can be used to offset some of the thickness that would be required without such surfacing. (*ENR*, April 11, 1935, p. 517.)

Pavement thicknesses

Recommendations as to pavement thicknesses were contained in the report of the committee on flexible pavements, which was presented by A. C. Benkleman of the Public Roads Administration. The committee believes that for cold-laid plant-mix a wearing surface having a finished thickness of 2 in. will generally prove adequate. Greater thickness imparts no more load supporting value to the pavement than equal thicknesses of well-compacted dense graded mineral aggregate. In general it would seem advisable to limit this type of bituminous surfacing to traffic wheel loads of not over 15,000 lb.

The minimum thickness for dense-

graded hot-mix surfacing is set by the committee at 2 in. For airport runways and taxiways where torsional stresses imposed by heavy wheel loads making a sharp turnaround are great, thicknesses greater than 2 in. are advisable. Until more information to the contrary is developed, the committee recommends minimum thicknesses of 2½ in. of this type of surfacing for loads between 15,000 and 25,000 lb.; 4 in. for 25,000 to 60,000 lb. and 5 in. for heavier loads. Because of the high tensile strength of dense-graded hot-mix pavements, it can be assumed that they add twice the load supporting value of dense-graded aggregate of equal thickness.

For base courses of the granular stabilized type the committee recommends for highway pavements having assumed maximum wheel loads of 10,000 lb. finished thickness ranging from 5 in. to 8 in. depending on the type of soil used.

Computation of total thickness

When loads greater than 10,000 lb. are to be carried, the committee states that the thickness study must include a determination of total pavement thickness, including surfacing, base and sub-base. As a generalization, the committee states that sub-bases will be required only on soils of the PRA A-4 to A-7 groups, except when otherwise required to prevent damage due to frost. The California bearing-ratio test is suggested as a means for determining the combined thickness of wearing surface, base course and sub-base, modifying the results in the light of local experience with pavements in the same vicinity.

A. T. Goldbeck of the National Sand and Gravel Association said that the ratio of calculated uniform pressure to the maximum pressure that will develop under a flexible pavement is about two. Tests he has made show this to be true. Also, this conclusion seems to be borne out in reports of the California tests.

T. E. Stanton, California Division of Highways, said that in using the result of the California tests it should be recognized that they were tests to destruction and so the conclusions might appear to be too conservative in the light of a relatively small number of repetitions of load such as would be obtained on recently completed runway pavements. Pavements ranging in thickness from 6 to 18 in. were built on saturated subgrades. Deflections in these pavements were measured and the deflections were correlated to the number of repetitions of load that were required to *make the pavement fail.*

Studies of Stabilized Bases

Experience in South Carolina with failures in stabilized bases was reported by J. J. Forrer, maintenance engineer, Virginia Department of Highways, chairman of the committee on maintenance of bituminous surfaces on stabilized bases. South Carolina has 87 miles of base stabilized with cement, 56 miles with tar, 391 miles with asphalt, and 20 miles with stone or gravel. The primary cause of failure in stabilized-base pavement is weakness of the subgrade. The cement-stabilized bases, generally, are in good condition. Tar stabilization in sandy soils has proved satisfactory, but in soils of high clay content, early failures were found at some points. Failures in asphalt-stabilized bases have been largely those caused by sub-grade defects, but there have been some failures in soils of high clay content. Bases stabilized with sand and gravel have been generally satisfactory on the small mileage laid to date.

On those sections of these stabilized-base highways where failures have occurred due to defective subgrade, the common method of treatment is to raise the grade slightly, laying a new stabilized base over the old one.

Stabilization with asphalts

New knowledge relating to fundamentals of soil stabilization with asphalt soils was revealed in a paper by V. A. Endersby of the Shell Development Co. Mr. Endersby said that while the cohesive qualities of soils generally have been ascribed to clay in the soil, the cohesion actually is all due to water, the clay merely indicating the particle size range in which hydraulic cohesion is fully developed. If soil is compacted with an excess of water in the voids, the films between the surfaces immediately expand and cohesion is lost, the soil swelling again as soon as the pressure on the soil is relieved. Thus every soil has an optimum water content for maximum compaction, which usually is in excess of the maximum required for cohesion. Consequently, the problem of compaction is to keep water from reaching the molecular layers of water that surround the soil particles as these layers are "thirsty" and will take up water, reducing the cohesion. The function of oil in stabilization work is not to produce cohesion but to protect the hydraulic cohesion.

Because of this condition, control of the mixing phases in consolidation with oils is vital to satisfactory results. A first essential is the amount of water to be added to dry soil. Mr. Endersby used the "fluff" point suggested by J. R. Benson and C. J. Becker in *Proceedings*, Association of Asphalt Paving Technologists, January, 1942. This is the point where the soil becomes loose or fluffy, with a moist appearance. The amount of water required to produce this condition, generally, is slightly in excess of the optimum for compaction of the soil. Finally, wide variations in the stability of like-combinations of soil, water and oil can be produced by changing either the method or the time cycle of the mixing. Too long a mixing time, generally, causes a decline in stability. Hence, from the practical angle, said Mr. Endersby, unless an engineer knows that the mixing is being done properly, all his laboratory tests are of little avail.

Soil wetting phenomena

In a paper on stability of soil as related to the wetting phenomena, Paul Rapp, associate chemist of the PRA, said that the density of soil that will be retained does not depend on the compaction that is applied in building the road but on the pressure to which the soil is subjected during service. Studies made to date indicate that the A.A.S.H.O. method for soil compaction is satisfactory for embankments up to 50 ft. high; for higher embankments, higher compaction may be necessary.

As to the wetting phenomena, Mr. Rapp said that the problem is one of learning how to keep soils from losing so much stability in the presence of waters. It seems probable, he added, that the solution will come through discovery of admixtures that

will facilitate the wetting of soil particles during compaction. Such wetting agents are now under study, but some of the plastic resins that offer much promise are now classed as critical materials.

Stress distribution in soils

D. P. Krynine, chairman of the committee on stress distribution in soils, reported progress on plans for a manual on stress distribution in soils designed especially for the use of highway engineers. In this manual an attempt will be made to clarify much of the confusion that now exists with respect to the subject of stress distribution in soils. It is hoped to produce a manual that will give field men essential information in an easily understandable form without excessive use of mathematics.

North Carolina soil studies

Further information on soil stabilization with cement was given by H. D. Hicks of the North Carolina Highway Department. The practice in that state is to make a laboratory determination lasting five or six weeks of the correct amount of cement required to stabilize each soil series and each "soil horizon" in the state. This makes it unnecessary to repeat a determination of the cement factor in the field on each job; all that is necessary is the much simpler task of determining the soil type or types to be treated on any job. Studies then are made to determine the proper moisture-density relationship for these particular soils as this has been found to be the controlling factor in getting stability. On the job, engineers of the department increase the optimum moisture factor by two points as it has been found that a moisture content slightly above that determined in the laboratory gives higher strength in the field.

Optimum figures for cement content also are increased slightly for work in the colder parts of the state. The state, however, still is studying the cement factor in the hope of finding that lesser amounts can be used satisfactorily.

Asked as to whether North Carolina has had difficulties with clay balls in making soil-cement mixtures, Mr. Hicks said that they have had little trouble, that these balls disintegrate when water is added. On this point, M. D. Catton, Portland Cement Assn., said that the association now has a research study under way to determine the amount of clay balls that is permissible. The moisture content of the clay ball seems to be a controlling factor; clay balls with moisture near the optimum for the mix do not appear to be harmful in such soil-cement mixtures.

Volume Changes in Concrete

Lack of suitable deposits of coarse concrete aggregates in parts of Kansas, Nebraska, Iowa and Missouri, have led to the use of natural mixtures of sand and fine gravel that can be obtained locally for the construction of concrete pavement. Cracking in these pavements developing progressively over a period of years, and in some cases complete disintegration of the surface, have resulted in extensive studies to determine the cause of this disintegration. The most recent studies were reported to the St. Louis meeting by F. H. Jackson and W. F. Kellerman of the Public Roads Administration. The sand-gravel aggregate used in the PRA study came from the Platte River valley in Nebraska. It is composed of quartz, granitic materials and some feldspar. Substantially all of it passes a $\frac{3}{8}$-in. sieve. In the accelerated test conducted by the PRA, alternate wetting and drying appeared to be more significant than alternate freezing and thawing. The alternate wetting and drying produced progressive expansion of the concrete, which the authors conclude is the cause of the cracking and ultimate disintegration. Why the progressive expansion developed, however, has not been determined to the satisfaction of the authors. Expansion could be checked by adding fines to the mix—which is deficient in fines—also by adding crushed limestone to bring the maximum size of the coarse aggregate up to $1\frac{1}{2}$ in. Wide variations in expansion were found in mixtures made with the same amount of aggregate and cement, but with different brands of cement, the cement having the highest alkali content producing a concrete with the greatest rate of expansion. However, the cement having the second highest alkali content produced a concrete having a lower rate of expansion than that of concrete made with cement having a still lower alkali content.

Where this aggregate must be used for concrete pavement construction, the authors recommend "sweetening" the aggregate with crushed limestone. They also recommended continuation of research on this subject.

W. H. Root, Iowa Highway Department, stated that his department has sweetened up this type of aggregate with limestone and has thereby reduced the amount of cracking but has not entirely eliminated it.

Sonic durability tests

A further discussion of concrete durability was presented by Prof. C. H. Scholer, Kansas State College, who reviewed some of the difficulties that surround attempting to determine the durability of concrete by laboratory tests. Resistance of concrete to alternate freezing and thawing is not the only factor to be considered, Professor Scholer said. Expansion, as noted in the previous paper, is very important in some types of structures. Laboratories, he added, have generally assumed that lack of durability is shown by loss of strength, by a gain in length or by loss of weight. Now he adds change in sonic modulus as a measure of loss in modulus of elasticity. This latter test, he said, while it has intriguing possibilities, also has limitations that must be recognized in evaluating results. For example, he pointed to the fact that a recovery of sonic modulus can be produced in test specimens by putting them back into the moist room.

Amplification of this discussion of sonic testing was provided in a paper by R. C. Valore, Jr., and J. C. Yates of the National Bureau of Standards, who reported on the effect of calcium chloride on the sonic values of concrete.

On the general subject of concrete durability, Thomas E. Stanton, California Division of Highways, stated that cracking of concrete in pavement need not be a cause for concern if the foundation is good. Also, he said that superficial cracking is not serious in many other types of structures unless it lets in moisture to attack steel reinforcing or permits alkali to enter and produce progressive disintegration of the concrete.

From Field and Office

WORKING PROBLEMS AND TIME-SAVING METHODS FOR ENGINEERS AND CONTRACTORS

Portable Rivet Heater Uses Butane Gas

For rivet heating inside the hulls where inconveniences and risks attending the use of natural gas practically rule out that fuel, this service now is being performed at Marinship Corp. in California by a "Blackfield Coffeepot", a job-made device using butane gas that heats rivets quicker, at lower cost and does a better job than do the usual coal heaters. With this rig, only 45 sec. is required for bringing a rivet up to white heat, instead of almost 3 min. with coal. Coal for 8 hr. costs $1 as compared to 30 c. for the butane gas supply.

Two types of these heaters are in use at Marinship; one with a 5-gal. container for use aboard ship is portable and carries enough gas to operate the heater for an 8-hr. shift. For use in the yard where a heavier outfit is not a disadvantage, the heater and a 50-gal. container are mounted on skids to facilitate moving about the yard or from shop to shop as needed.

The heater was devised by William Blackfield, assistant area planning engineer, Marinship Corp.

A 5-gal. supply of butane enables this heater to be used inside ship hulls.

Protection for Wires on Shop Floor

When it is necessary to lay electric leads, and occasionally other utility lines, across a shop floor where heavily loaded steel tires pass to and fro, some form of protection is needed to safeguard the utilities. This has been provided at a western shipyard by an assembly of three steel plates and some wedge-shaped supports, welded together so that from either direction truck wheels will go up a slight rise to pass over the wires which are dropped through a slot between the two deck plates. By making the length of the steel plates as measured transverse to the roadway, only slightly more than the width of the trucks that use it, ample space is left in the passageway for workmen to pass around rather than to be required to step over the protective device.

Concrete Replaces Metal For Traffic Markers

The massive metal markers that have long been anchored to pavements in the approach to safety zones are being taken from Los Angeles streets by city authorities and contributed to the scrap pile for war uses. In their places are appearing precast concrete markers which are believed to fulfill the required functions in every way.

Each concrete marker has the top 1½-in. length of two old lag screws embedded in the underside with a length of 3 or 3½-in. projecting. The projections are inserted in holes drilled into the pavement; a sulphur compound (similar to that used for capping concrete cylinders) fills the space in the holes around the screws and hardens rapidly to anchor the blocks in place.

If there is some roughness of the pavement surface where the markers are to go in, cement grout is used to smooth it off before the markers are set. Red reflector buttons are cast in the concrete to reflect the beam from automobile headlights.

Concrete replaces metal safety zone markers in Los Angeles.

Guide Line for Handling Stacks Above Smoke-box Breeching

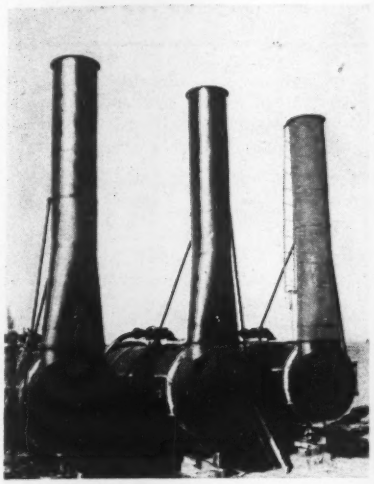
When portable boilers are used on construction jobs for power, it is often necessary either to carry a long ladder, or to include such a unit on the stack, as is shown with the right boiler in an accompanying photograph. Even with a ladder, rigging the line is hazardous, and requires the services of men often needed elsewhere.

By welding eyes at top and bottom of stack, and stringing a ½-in. wire line between them, one contractor forms a guide which eliminates the use of the ladder, as shown by all three units in the picture. The line insures a straight lift for replacing

or removing stacks from the smoke-box breeching.

To remove the stacks the hoisting line is simply given a wrap around the guide line and the power applied. The loop slides along the guide until the top eye is reached, when the lifting starts.

To provide easier loading on the truck, the stacks also are equipped with a reinforcing band at the mid-section. To the band is welded a loop for attaching a lifting hook. This arrangement prevents crushed stacks so often resulting from the use of a sling around stacks of thin metal. It also speeds up handling and prolongs stack life.—Charles C. Lynde, P. O. Box 1129, Houston, Tex.



Removal of stacks from above the smoke-box breeching of portable boilers can be made easier if a guide line of the type illustrated is added.

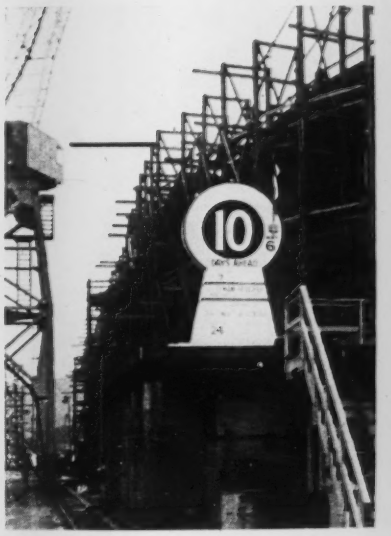
Retaining Hooks for Hoist Line

When a rope around the niggerhead on the hoisting equipment supplements the usual wire-line equipment, the rope is frequently far from its guide sheave when needed. Thus time must be lost while the string-up is completed. To retain the line close to the sheave, a Texas contractor welds a pair of hooks alongside the sheave, one on either side, and facing in opposite directions across the rope groove.

Instead of being required to thread with the end of the rope, as with a solid guide ring, the line is simply passed around one hook end, through the space formed by the horizontal sections of the hooks, and around the end of the second hook. When this line is in place the two hooks combine to form a ring that automatically holds the line close to the sheave. Clearance between hook shank and sheave is such that the rope cannot become jammed.—C. C. Lynde, Houston, Tex.

Unique Sign Keeps Shipyard Workers Posted on Progress

The number of days ahead of or behind schedule is announced on each way at Marinship Corp., in California, by a large sign, which is changed from time to time, to announce to yard workers the relative speed that is being made on the vessel that occupies each way. The way farthest ahead of schedule gets a flag that flies beside the number, and the color behind the figures announces the number of days, changing from blue for "ahead" to a red background if the progress lags behind the established schedule.



A sign beside each way announces number of days ship is ahead of or behind schedule.

An Easy Way to Obtain Square Root Using a Slide Rule

In these days of mechanical calculators there may be some engineers with computing machines always at their elbows in their offices who do not even have a slide rule near by.

Articles by Sydney L. Goldberg and Tracy W. Simpson in *Engineering News-Record* July 2 and 16, 1942, p. 93 and 59, respectively, suggest that the common dependence on mechanical computors may sometimes cause an engineer to forget that now and then he could save time by remembering and using a little arithmetic.

For example, take the number 5331.172 used by Mr. Simpson; the slide rule indicates the square root is close to 73.0. Dividing 73 into 5331.172 on a calculator the result is 73.0297534, if that many figures are available on the machine. The mean between 73.0 and the quotient is 73.0148767, which is pretty close to the square root, 73.0148752. Thus, the result is correct to seven figures and is not very much out in the eighth.

Applying this method to Mr. Goldberg's number 712,336 and using as a divisor the approximate square root, 845, estimated by slide rule, it is found that the mean of the two factors is 844.00059. The correct root being even 844, the error is in the sixth figure. Obviously the error in final result is dependent on the slide rule trial square root, but such error should seldom exceed that in the last illustration. When desired, greater accuracy can be obtained by a second solution, using the first result obtained as the next divisor.

Conversely it is sometimes worth while to square a number as follows: The square of 35 is 30 times 40, plus the square of 5, or 1,225 and the square of 98 is 100 times 96, plus the square of 2 or 9,604.

Perhaps these methods are easier to remember than the computing machine rules described in the articles referred to.—Horace P. Boardman, *Consulting Civil Engineer, Reno, Nevada.*

Book Notes and Reviews

The month's addition to the engineer's reading and reference list

After the War

COLLAPSE OR BOOM AT THE END OF THE WAR—By Harold G. Moulton and Karl Schlotterbeck. The Brookings Institution, Washington, D. C. 25c.

Any one who is giving thought to what economic conditions are to be like in this country after the war will find this pamphlet well worth the hour required to read it. The authors make no predictions as to what is to happen. They do, however, set forth clearly the factors favorable to a boom in the post war period and those that might produce an economic collapse.

Planning Our Cities

CAN OUR CITIES SURVIVE?—By Jose Luis Sert. The Harvard University Press, Cambridge, Mass. 259 pp. $5.

No promised undertaking of the postwar period grips the imagination with more vigor than does the rehabilitation of our cities. Successful execution of such projects will call for a broadness of vision and bold courage possessed only by those who refuse to be shackled to the traditions of the past.

But vision and courage must be seasoned with realism. Thus it was that the Congres Internationau d'Architecture Moderne undertook a study of urban planning in 1930 by first making an analysis of thirty-three European and American cities. With this as a basis, there were formulated proposals for the replanning of cities. J. L. Sert, vice-president of the C.I.A.M., was then asked to compile this material.

The result is a fundamental and comprehensive treatise on the subject of city planning. In its 15 chapters it makes careful examination of the four elementary functions—dwelling, recreation, work and transportation—and relates these to the cultural, social and political needs of large population groups. And finally it proposes safeguards against repetition of mistakes that were made in past city planning.

For the engineer the book will supply background and a viewpoint far beyond that encompassed in so-called technical literature. The arrangement of the text and a liberal number of pictures add special interest to the book.

For Practical Mechanics

MERRIMAN'S STRENGTH OF MATERIALS—Revised by E. K. Hankin. Eighth Revised Edition. 148 pp. John Wiley & Sons, New York; Chapman & Hall, London. $1.50.

In rewriting and revising Merriman's "Strength of Materials," the present author, Edward K. Hankin, states that he has attempted to write a basic textbook for non-technical students and mechanics. In doing this he has shifted the emphasis from the construction and civil engineering field to the industrial field, and has added new information on modern industrial material such as iron alloys, plastics and aluminum.

Miscellaneous Notes on Booklets and Reprints

EMERGENCY ALTERNATE SPECIFICATIONS FOR PORTLAND CEMENT are included in the sixth edition of the A. S. T. M. Standards on Cement. These were issued in the interest of expediting procurement or conserving materials during the national emergency. They are intended as alternates to the A. S. T. M. standard specifications for portland cement. (American Society for Testing Materials, 260 South Broad St., Philadelphia, Pa. $1.35).

WATER TREATMENT WITH LIMESTONE has been studied at Texas A. & M. College, and the results reported in Bulletin No. 65. It is indicated that suitable powdered limestones might be applied by dry feed to rapid sand filter plants for correction of corrosion; for new plants, filters of crushed limestone are reported to operate with great ease and economy. Copies of the bulletin are available without charge on application to the Texas Engineering Experiment Station, College Station, Texas.

A "WAR EMERGENCY EDITION" of the 1935 Manual on Uniform Traffic Control Devices has been compiled by a special joint committee of the American Association of State Highway Officials, the Institute of Traffic Engineers and the National Conference on Street and Highway Safety. It gives special attention to problems of emergency traffic movements, blackouts and shortages of critical materials. The manual has been published in a restricted edition by the Public Roads Administration, Washington, D. C. Traffic officers and those connected with the manufacture or installation of traffic-control devices should apply to the PRA indicating their special need for the manual.

New Engineering Books

CONCRETE MANUAL—Fourth Edition. 476 pp. Bureau of Reclamation, Department of the Interior. $1. (Distribution limited to the United States).

A. S. T. M. STANDARDS 1942—Part II Nonmetallic Materials—Constructional. 1489 pp. Non-members $9, members $6.

AMERICAN DIESEL ENGINES—By E. F. Goad. 313 pp. Harper & Brothers, New York and London. $2.75.

HANDBOOK OF BRICK MASONRY CONSTRUCTION—By John A. Mulligan. 526 pp. McGraw-Hill Book Co., New York and London. $5.

STRESSES IN FRAMED STRUCTURES—Second Edition. 642 pp. McGraw-Hill Book Co., New York and London. $5.

THE PORT OF NEW YORK AUTHORITY—By Erwin Wilkie Bard. 352 pp. Columbia University Press, New York and London. $3.50.

TOWN PLANNING AND ROAD TRAFFIC—By H. Alker Tripp. 118 pp. Edward Arnold & Co., London; Longmans, Green and Co., New York. $3.25.

MANUAL OF EXPLOSIVES, MILITARY PYROTECHNICS AND CHEMICAL WARFARE AGENTS—By Jules Bebie. 171 pp. The MacMillan Co., New York. $2.50.

TRANSPORTATION AND NATIONAL POLICY—May 1942. National Resources Planning Board, Washington. 513 pp. Superintendent of Documents, Washington. $1.25.

Reports and Pamphlets

VERMONT ROADS AND BRIDGES—Eleventh biennial report, State Highway Board and Twenty-second biennial report, Department of Highways. Montpelier, Vt.

COUNTY OF ESSEX, MASSACHUSETTS—Annual report of the county engineer, Salem.

(Continued on page 76)

STEPPING STONES TO VICTORY!

EACH landing we make, each enemy position we capture is a stepping stone toward Victory. Each is part of a great chain, leading to Berlin, Rome, and Tokio. But remember, the men who tread this path need backing from all of us at home.

For example, strict conservation of batteries is vitally important... and the four simple rules for battery care may be compared to stepping stones. Follow them to make batteries last. Buy to last and save to win.

FIRST STEPPING STONE—Keep adding approved water at regular intervals. Most kinds of local water are safe in an Exide Battery. Ask us if yours is safe.

SECOND STEPPING STONE—Keep the top of the battery and battery container clean and dry at all times. This will assure maximum protection of the inner parts.

THIRD STEPPING STONE—Keep the battery fully charged—but avoid excessive overcharge. There's always a right way to do any job and a storage battery will last longer when charged at its proper voltage.

FOURTH STEPPING STONE—Keep records of water additions, voltage, and gravity readings. Don't trust your memory. Write down a complete record of your battery's life history. Know what's happening!

If you wish more detailed information, or have a special battery problem, don't hesitate to write to Exide. We want you to get the long-life built into every Exide Battery. Ask for Booklet Form 2399.

THE ELECTRIC STORAGE BATTERY CO., Philadelphia
The World's Largest Manufacturers of Storage Batteries for Every Purpose
Exide Batteries of Canada, Limited, Toronto

Exide
BATTERIES
FOR CRANKING
DIESEL ENGINES

CONTRACT UNIT PRICES

What contractors are bidding on different kinds of construction work

BRIDGE SUBSTRUCTURE NEW JERSEY

OWNER: New Jersey State Highway Dept., Trenton. Morris Goodkind, bridge engineer.

PROJECT: Substructure of bridge over tracks of New York & Long Branch Railroad, on Route 35, Borough of Sayreville, Middlesex County, N. J. Includes all foundation excavation, concrete in structures (abutments) and balustrade; timber piling; cinder backfill; concrete cribbing; borrow excavation; rock fill (crib wall); reinforcing steel; waterproofing; and clearing site.

CONDITIONS: Contractor to furnish all materials and complete work in 75 working days. Rail and highway transportation facilities available. Wage rates are those prevailing in Middlesex County.

BIDS: Four bids were received December 28, 1942, ranging from the low of $108,607 to $121,484.

1. Fehlhaber Pile Co., New York, N. Y. (low bidder) $108,607
2. Ell-Dorer Contracting Co., Irvington, N. J. 117,566
3. H. L. Harrison & Son, Inc., Newark, N. J. 120,601
4. Franklin Contracting Co., Newark, N. J. 121,484

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Foundation excavation	2,350 c. y.	$11.00	$7.95	$10.00
2. Relocate existing stairways	Lump Sum	300.00	500.00	500.00
3. Timber piles	9,600 l. f.	.40	1.20	.85
4. Class C concrete (structures)	3,165 c. y.	18.00	19.60	19.50
5. Concrete balustrade	59 l. f.	7.00	6.00	10.00
6. Cinder backfill	3,030 c. y.	2.00	2.25	2.00
7. Concrete cribbing	3,122 c. f.	1.75	2.50	2.50
8. Borrow excavation	2,740 c. y.	1.00	1.50	1.25
9. Rock fill, crib wall	550 c. y.	7.00	3.00	4.50
10. Reinforcing steel (structures)	9,620 lb.	.10	.10	.10
11. Waterproofing	627 s. f.	.50	.50	.50
12. Foundation excavation, crib wall	1,545 c. y.	1.00	1.50	2.50
13. Clearing site	Lump Sum	300.00	500.00	1,230.00

AIRPORT PAVING AND GRADING KANSAS CITY, MO.

OWNER: Civil Aeronautics Administration, Fifth Regional Office, Kansas City, Mo.

PROJECT: Grading, drainage, paving and miscellaneous items in connection with the construction of the Kansas City Auxiliary Airport located south of Kansas City, Mo., and on property owned by the city. Includes necessary earth and rock excavation, watering, furnishing and laying drainage pipe, concrete manholes, brick manholes, reinforcing steel, rough stone masonry, and riprap in Schedule I. Schedule II requires 327,350 square yards of plain 9-7-9-in. concrete pavement, necessary underground ducts, and concrete gutter 9-in. thick.

CONDITIONS: Contractor to furnish all materials and complete Schedule I in 200 days, and Schedule II in 150 days. Rail and highway transportation facilities available at project site. City to extend water supply, and to provide source of electrical energy at the site. Priority rating is AA-4. Minimum wage rates specified are: skilled labor, $1.00 to $1.65 per hour; semi-skilled, 90c. to $1.37½; and common, 90c.

BIDS: Six bids were received on the combination of Schedules I and II November 30, 1942, ranging from the contract low of $1,471,336 to $2,493,310. Schedules III and IV, which were identical with Schedules I and II except for the shorter time allowed for completion, had two bidders. They were: Western Contracting Corp., Sioux City, Iowa, $1,684,456; and the Peter Kiewit Sons Co., and Condon-Cunningham Co., Omaha, Nebr., $1,910,742.

LIST OF BIDDERS: (Schedules I and II combined.)

1. Koss Constr. Co., Des Moines, Iowa (contract) $1,471,336
2. Western Contracting Corp., Sioux City, Iowa 1,638,921
3. Harrison Engr. & Constr. Corp., Kansas City, Mo 1,684,290
4. Stephen-Brown Co., & Perry McGlone Constr. Co., Kansas City, Mo. 1,774,911
5. Peter Kiewit Sons Co., & Condon-Cunningham Co., Omaha, Nebr. 1,828,007
6. Lancaster Corporation, Omaha, Nebr 2,493,310

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Common excavation	640,000 c. y.	$0.42	$0.35	$0.50
2. Solid rock excavation	200,000 c. y.	1.30	1.20	1.35
3. Water, in place	5,000 M gal.	Free	1.00	1.00
4. 6-in. drainage pipe	4,480 l. f.	1.40	2.25	1.62
5. 8-in. drainage pipe	10,280 l. f.	1.75	2.50	1.79
6. 10-in. drainage pipe	7,310 l. f.	2.10	2.80	2.17
7. 12-in. drainage pipe	5,870 l. f.	2.45	3.00	2.40
8. 15-in. drainage pipe	4,600 l. f.	3.20	3.70	3.28
9. 18-in. drainage pipe	2,350 l. f.	4.20	5.10	4.13
10. 21-in. drainage pipe	1,060 l. f.	5.00	6.70	5.61
11. 24-in. drainage pipe	280 l. f.	6.00	8.00	11.20
12. 27-in. drainage pipe	370 l. f.	7.00	9.00	41.72
13. 30-in. drainage pipe	270 l. f.	8.00	10.00	11.91
14. Rock excavation for drainage struct.	3,000 c. y.	10.00	8.50	8.58
15. Earth excavation, for ditches	2,000 c. y.	1.50	1.00	5.28
16. Concrete manholes	149 ea.	170.00	130.00	204.04
17. Extension manholes, below 6-ft.	40 ft.	25.00	30.00	33.02
18. Brick manhole, iron grating	14 ea.	170.00	140.00	204.04
19. Extension brick manholes	20 ft.	25.00	30.00	32.06
20. Concrete for headwalls	10 c. y.	50.00	50.00	61.10
21. Reinforcing steel	1,000 lb.	.07	.07	.09
22. Rough stone masonry	10 c. y.	40.00	25.00	41.72
23. Riprap, as ordered	5,000 s. y.	2.50	4.00	2.33
24. Underground duct	6,300 l. f.	1.00	2.50	1.50
25. Underground duct, additional run	2,100 l. f.	.50	1.00	.55
26. 9-7-9 in. concrete pavement	327,350 s. y.	2.13	2.72	2.46
27. Additional for heat and protection	80,000 s. y.	.25	.20	.15
28. Concrete gutter, 9-in. thick	16,230 s. y.	3.20	3.45	4.25

HIGHWAY, TEXAS

OWNER: Texas State Highway Commission, Austin; D. C. Greer, state highway engineer.

PROJECT: Grading, structures, and concrete paving 12.682 miles of U. S. Highway 271 and State Route 135 in Smith, Gregg and Wood Counties, Texas. Project runs from Mineola to 0.6 miles east of the Van Zandt County line, and from 4.2 miles southwest of the Gregg County line to Gladewater.

CONDITIONS: Contractor to furnish all materials. Rail and highway transportation facilities available. Prevailing wages to be paid.

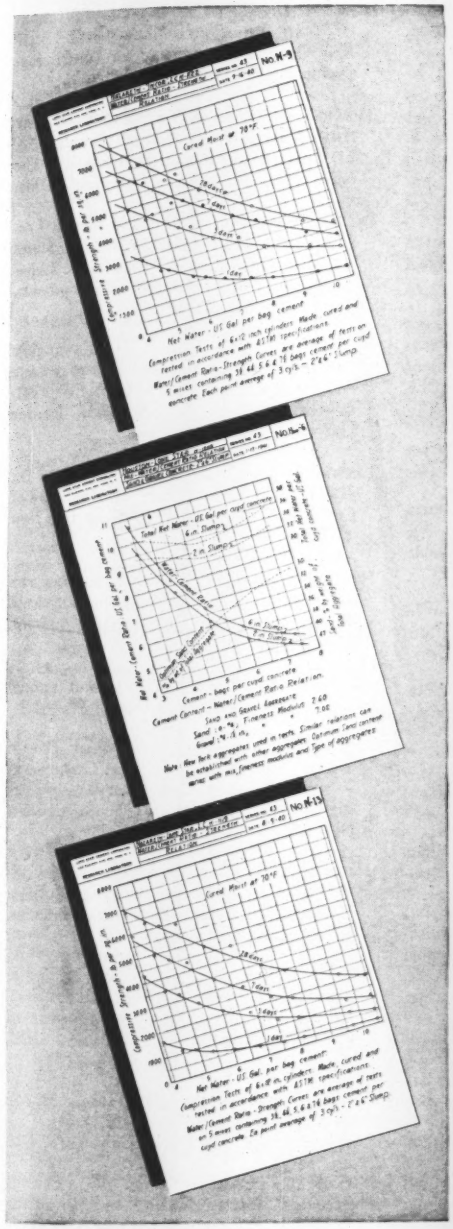
BIDS: Four bids were received December 15, 1942, ranging from the low of $476,252 to $514,183.

LIST OF BIDDERS:

1. L. H. Lacy Co., Dallas, Tex. (low bidder) $476,252
2. Harrison Engr. & Constr. Corp., Kansas City, Mo. 479,731
3. Texas Bitulithic Co., Dallas, Tex. 501,666
4. Standard Paving Co., Fort Worth, Tex. 514,183

Item	Quan.	Unit Prices (1)	(2)	(3)
1. Common and special road excav.	74,776 c. y.	$0.30	$0.39	$0.35
2. Common and special borrow	3,183 c. y.	.42	.39	.35
3. Common and spec. channel excav.	1,046 c. y.	.42	.50	.45
4. Unclassified structural excav.	184 c. y.	2.50	2.00	2.50
5. Blading embankment	219 hr.	4.75	4.00	6.00
6. Overhaul	18,549 ½-mi. y.	.12	.10	.10
7. Sprinkling	4,094 M gal.	1.50	1.00	1.50
8. Rolling	151 hr.	6.00	5.00	5.50
9. Salvage and replace flexible base	5,480 c. y.	1.60	1.00	1.70
10. Flexible base	6,946 c. y.	1.10	.80	1.30
11. Add'l. quarter-mile haul	222,332 c. y.	.033	.03	.033
12. Concrete pavement	180,186 s. y.	2.23	2.27	2.35
13. Class A concrete	284.61 c. y.	42.00	33.00	35.00
14. Reinforcing steel	9,380 lb.	.063	.10	.10
15. 12-in. plain conc. culv. pipe	128 l. f.	2.22	2.00	1.50
16. 24-in. plain conc. culv. pipe	226 l. f.	2.60	3.00	2.80
17. Remove old structures (culv.)	6 ea.	140.00	50.00	40.00
18. Remove old structures (bridges)	1 ea.	415.00	300.00	330.00
19. Monolithic concrete curb	440 l. f.	.42	1.00	1.00
20. Concrete curb and gutter	480 l. f.	1.90	2.50	3.00
21. Right-of-way markers	8 ea.	2.40	2.00	1.00

15 YEARS' PERFORMANCE
PROVES BASIC ADVANTAGES OF
SELECTIVE CONCRETING



FIFTEEN YEARS AGO it took concrete a week or more to attain service strength. Schedules were slow and winter work costly and uncertain. In 1927, 'Incor' 24-Hour Cement was introduced, providing service strength in one day, eliminating unproductive time waiting for concrete to harden—and making concrete a ready-to-use, year-around building material.

Mixed with 6 gal. water, 'Incor' produces 2000-lb. concrete in 24 hours. That permits early stripping and faster form re-use, cutting form costs 50% or more. Winter construction is simplified, freezing risk reduced, and heat protection cut by 3 to 5 days on each pour.

Over 15 years' successful field performance has proven 'Incor's value to construction men. Compare 'Incor' savings against its extra cost. Let form, time and curing costs—and in winter, heating costs—determine whether to use Lone Star or 'Incor.'* Construction economies, both in time and money, are all-important.

*Reg. U.S. Pat. Off.

Selective concreting saves days—and dollars

LONE STAR CEMENT CORPORATION

Offices: ALBANY · BIRMINGHAM · BOSTON · CHICAGO · DALLAS · HOUSTON · INDIANAPOLIS · JACKSON, MISS. KANSAS CITY · NEW ORLEANS · NEW YORK · NORFOLK · PHILADELPHIA · ST. LOUIS · WASHINGTON, D. C.

LONE STAR, WITH ITS SUBSIDIARIES, IS ONE OF THE WORLD'S LARGEST CEMENT PRODUCERS . . 15 MODERN MILLS . . 25-MILLION BARRELS ANNUAL CAPACITY

WYTEFACE
"A"
TRADE MARK
STEEL TAPES

GRADUATED IN INCHES OR TENTHS

EASY-TO-READ, *raised* black graduations on crack-proof white surface . . . resist abrasion from rock, sand, scraping over rails, pipe, concrete, etc. In all sizes and types—in cases or reels. Ask your dealer—or write for catalog.

EST. 1867
KEUFFEL & ESSER CO.
NEW YORK • HOBOKEN, N. J.
CHICAGO • ST. LOUIS • SAN FRANCISCO • LOS ANGELES • DETROIT • MONTREAL

Reports and Pamphlets

(*Continued from page 72*)

PROVO CITY CORPORATION CITY ENGINEER'S REPORT—1941. Provo City, Utah.

AMERICAN INSTITUTE OF STEEL CONSTRUCTION, Annual Report. 101 Park Ave., New York.

PASADENA, CALIF. — Twenty-ninth annual report. Pasadena Water Department, Pasadena, California.

ST. LOUIS, MO. — Annual report of the Water Commissioner 1942.

CARRIAGEWAY DESIGNS FOR SERVICE ROADS —Wartime Road Note No. 5. Department of Scientific and Industrial Research, Teddington, Middlesex, England. British Library of Information, Rockefeller Center, New York.

PLAIN CONCRETE PAVEMENTS FOR HIGHWAYS —Portland Cement Association, 33 West Grand Ave., Chicago.

THE DESIGN OF PLAIN-CONCRETE STREET PAVEMENTS FOR CITY STREETS OF VARYING TRAFFIC CLASSES—Portland Cement Association, 33 West Grand Ave., Chicago.

POST-WAR AGENDA — National Resources Planning Board, Washington, D. C.

WAR-TIME TRENDS IN STATE LEGISLATION OF INTEREST TO HIGHWAY USERS—National Highway Users Conference, Washington, D. C.

IS THERE ENOUGH MANPOWER?—By Harold W. Metz. The Brookings Institution, Washington, D. C. 25c.

WHEN DEMOBILIZATION DAY COMES—National Planning Association, Washington, D. C. 25c.

PROPOSED POST-WAR WORKS PROGRAM—City Planning Commission, Municipal Building, New York. 25c.

MODERN DEVELOPMENTS IN REINFORCED CONCRETE—No. 3. Portland Cement Association, 33 West Grand Ave., Chicago.

A GLOSSARY OF HOUSING TERMS—Building Materials and Structures Report BMS91. National Bureau of Standards, Superintendent of Documents, Washington, D. C. 15c.

ROCHESTER, NEW YORK—Fourth annual municipal report. Division of Public Relations, Dept. of Commerce, Rochester, N. Y.

KENTUCKY STATE BOARD OF REGISTRATION FOR PROFESSIONAL ENGINEERS—Fourth annual report. Lexington, Ky.

CHICAGO, ILLINOIS—Sixty-sixth annual report of the Department of Public Works.

CITY OF GRAND RAPIDS SEWAGE TREATMENT PLANT—Annual report on operation. Department of Public Service, Grand Rapids, Mich.

MEETING WARTIME DEMANDS FOR PASSENGER TRANSPORTATION IN THE NEW YORK, NEW JERSEY METROPOLITAN AREA—Regional Plan Association, Inc., 400 Madison Ave., New York. 25c.

40 YEARS OF BUILDING—To commemorate the 40th anniversary of the founding of The Turner Construction Company, New York.

A YEAR OF RAILROAD INFORMATION—1942 Edition. Eastern Railroad Presidents Conference, 143 Liberty St., New York.

HOW MANAGEMENT CAN INTEGRATE NEGROES IN WAR INDUSTRIES—New York State War Council, Committee on Discrimination in Employment, Albany, N. Y.

TRAVEL AND TRADE IN TWENTIETH CENTURY OHIO—By John M. Weed. Circular No. 44, Engineering Experiment Station, The Ohio State University, Columbus, Ohio.

DIGEST OF STATE AND FEDERAL LABOR LEGISLATION—Bulletin No. 51. United States Department of Labor, Division of Labor Standards. Superintendent of Documents, Washington, D. C. 10c.

REPORT OF THE RESEARCH AND EXTENSION ACTIVITIES ENGINEERING SCHOOLS AND DEPARTMENTS FOR THE SESSIONS OF 1941-42—Research Series No. 85. Purdue University, Lafayette, Ind.

LESSON OF THE LAST WORLD WAR—By Dr. James T. Shotwell. American Institute of Consulting Engineers, 75 West St., New York.

NATIONAL EMERGENCY SPECIFICATIONS FOR THE DESIGN OF REINFORCED CONCRETE BUILDINGS — War Production Board, Washington, D. C.

DUBUQUE, IOWA—The forty-second annual report of Water Department.

PROTECTION AND MAINTENANCE OF PUBLIC WATER SUPPLIES UNDER WAR CONDITIONS —Medical Division, Sanitary Engineering Bulletin No. 1. U. S. Office of Civilian Defense, Washington, D. C.

MUNICIPAL SANITATION UNDER WAR CONDITIONS—Sanitary Engineering Bulletin No. 2. U. S. Office of Civilian Defense, Washington, D. C.

LOCAL TRANSPORTATION—War Bibliografphies No. 3. By Dorothy Campbell Tompkins. University of California, Bureau of Public Administration, Berkeley, Calif. 35c.

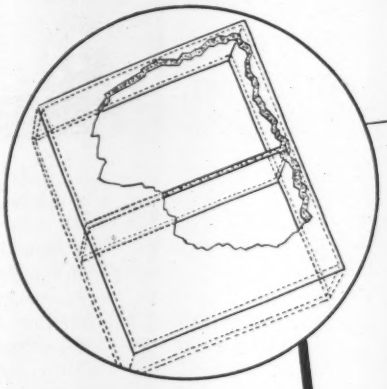
BOMBS, BUILDINGS AND SHELTERS—ARP FOR THE HOME—By William H. Hayes. Columbia University Press, New York. 60c.

CHEMICAL COMPOSITION OF SEWAGE SLUDGES, WITH PARTICULAR REFERENCE TO THEIR PHOSPHORIC ACID CONTENTS—Bulletin 699, New Jersey Agricultural Experiment Station, Rutgers University, New Brunswick, New Jersey.

AN INTRODUCTION TO THE ECONOMICS OF CIVIL ENGINEERING—By J. K. Finch. Columbia University, New York. $1.

CONCRETE EXAMPLE

of FUEL OIL TANKS — Oilproof and Waterproof with ANTI-HYDRO



Any size or shape of concrete tank can be built to fit accessible or available space.

CONDITIONS CONCRETE As Alloy Conditions Steel

Increases DENSITY

Increases hydration and dispersion of Portland cement. Increases adhesion to steel. Reduces shrinkage and voids in concrete. Cures internally and eliminates need for surface curing.

Increases HARDNESS

Permits opening concrete to traffic or other use in 24 hours. Produces wear resistant and dustless surface.

Increases STRENGTH

Reduces water-cement ratio for specified slump (see U. S. Engineers Test). Increases early and ultimate strength with regular Portland cement (see tests of independent laboratories).

Increases DURABILITY

100% impermeable concrete (Government and independent tests). Weatherproof concrete (see freeze and thaw tests). Prevents penetration of fuel oil, water and moisture.

SOLVES PRIORITY PROBLEM ON STEEL FOR TANKS

Concrete integrally cured with Anti-Hydro, is an excellent substitute for—steel in fuel oil and other storage tanks, reservoirs, cisterns and waterworks as proven by thousands of installations the past 38 years.

GORHAM MANUFACTURING COMPANY
SILVERSMITHS AND GOLDSMITHS

PROVIDENCE, RHODE ISLAND

January 11, 1943

Anti-Hydro Waterproofing Company
265-277 Badger Avenue
Newark, N. J.

Gentlemen:

Replying to your letter of December 31st inquiring about the concrete tanks, which were installed for oil storage, I believe that the tanks you refer to are the ones built by the J. W. Bishop Company in 1918 in which Anti-Hydro was used integrally in the concrete to prevent the infiltration of water from the outside.

The tanks were built as dual units, the overall dimensions being 65'x55'x10' deep. A concrete partition in the center divides them into two tanks, each 32'x55'x10' deep. The tank has a concrete top which is flush with the ground.

For many years Bunker C oil was stored in only one side of the tank and we never had any oil seep thru the dividing wall; in fact, for a period of six years water was stored in one tank and oil in the other without the water becoming contaminated by the oil.

If you would like to have the construction details of this installation I am sure that the J. W. Bishop Company, Worcester, Massachusetts, will be glad to furnish you with this information.

Very truly yours,

T. W. Goodwin
Chief Engineer

FORMER FIRE ACCIDENT DELAYED BY CARRIER OR CIRCUMSTANCES BEYOND OUR CONTROL

THE "EVIDENCE"

A LETTER THAT SPEAKS FOR ITSELF

GUARANTEED RESULTS

A 5-year maintenance guarantee, based on 38 years of successful performance, can be furnished on Anti-Hydro gauged concrete floors, installed under manufacturer's supervision.

"ANTI-HYDRO"
FOR PERMANENT CONCRETE
HARDENS WATERPROOFS

ANTI-HYDRO WATERPROOFING CO.
263 Badger Avenue • Newark, N. J., U. S. A.
Phone: Bigelow 3-5440

ANTI-HYDRO of CANADA, Ltd.
641 Place St. Charles
MONTREAL • CANADA

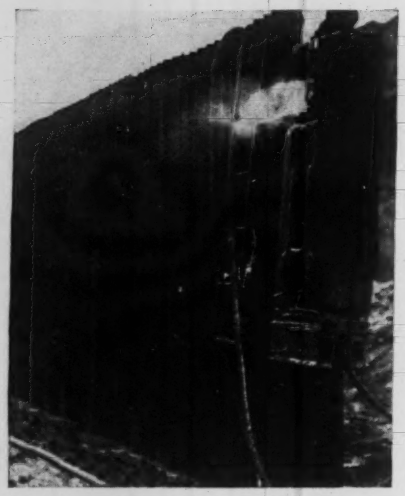
NATIONALLY DISTRIBUTED by building supply dealers in all principal cities of the United States and Canada

Anti-Hydro Waterproofing Co.
265 Badger Ave., Dept. M., Newark, N. J.
Please send me A. I. A. folder on Anti-Hydro.

Name_____
Firm Name_____
Address_____
City_____ State_____

Send This Coupon for A. I. A. Folder

THIS SHEETING SAVES STEEL... FOR 22 TANKS



Sometimes metal sheeting is a military *must* on vital war projects.

Just such a job recently required 37,000 square feet of steel sheeting. Figured with ordinary hot rolled sheeting, about 534 tons of metal would have been used. Doing the work with light-weight ARMCO Sheeting required only 179 tons — a saving of 355 tons of precious steel, or enough to build 22 light tanks.

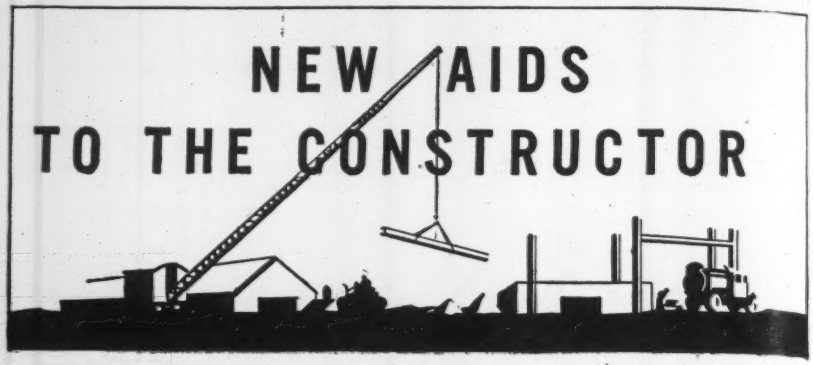
ARMCO Sheeting also saves time and labor. A smooth surface and small displacement permit fast, easy driving. On temporary jobs it can readily be pulled and used over and over again. Lengthwise corrugations provide ample strength, also make the sheeting nestable, simplifying storage and shipping.

You can save time and metal by ordering ARMCO Sheeting in the exact gage and type you need. Interlocking, Flange and Clip-types are supplied in 8, 10 and 12 gage, in 12 and 14-inch widths, and in standard lengths up to 18 feet. Write for help on unusual applications. Armco Drainage Products Assn., 45 Curtis St., Middletown, Ohio.

ARMCO

ARMCO SHEETING

NEW AIDS TO THE CONSTRUCTOR



Earthmoving Tire

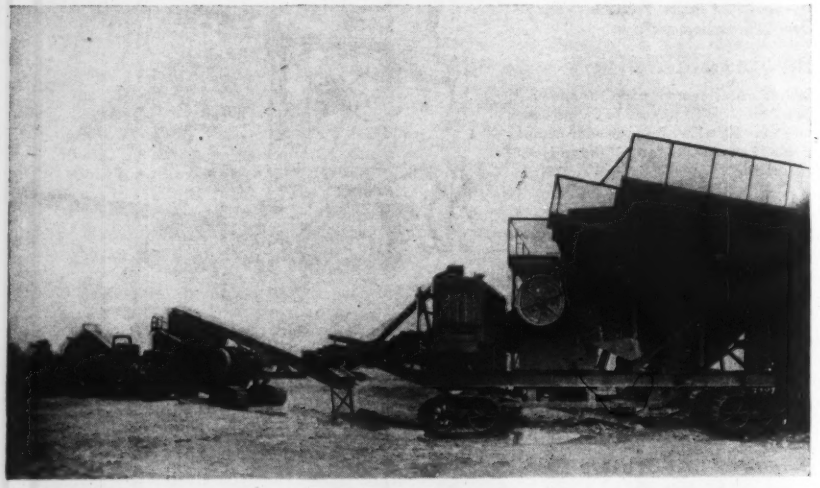
An earthmover and excavating tire, said to possess a new degree of durability and strength and providing 98 per cent more resistance to body breaks than tires heretofore available for this field of operation, has been announced by the Firestone Tire & Rubber Co. Identified as Firestone Rayon Multi-Ply Tire, the tire was developed for the threefold purpose of increasing tire life, conserving rubber and speeding up earthmoving and excavating operations. This was achieved through a number of new design features, all of which are said to contribute to greater strength of the tire body.—*Firestone Tire & Rubber Co., Akron, Ohio.*

Lubricating Oil

The Gulf Oil Corp. has announced a new brand of lubricating oils which it calls Gulf Dieselube H. D. (Heavy Duty). These oils are made to meet U. S. Army specifications for internal combustion engines for ground equipment such as trucks, tanks and jeeps. They have also been approved by the leading manufacturers of diesel engines for tractors and trucks. These oils are being sold to the Government and to commercial consuming accounts operating tractors, buses and motorized industrial equipment. They contain blended ingredients which reinforce their resistance to the heat encountered in tank motors and transmissions, providing increased film strength, and offering increased protection to alloy bearings against corrosion.—*The Gulf Oil Corp., Pittsburgh, Pa.*

Gypsum Products

A group of new gypsum products developed to meet the immediate demands of war-time construction has been put on the market by the Celotex Corp. The



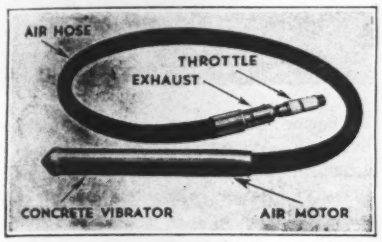
Flexible Rock Plant

Pioneer Engineering Works, Minneapolis, Minn., has designed and is building a flexible plant that can be used in either a rock quarry or a gravel pit. The plant will crush, screen, wash, and produce two or three sizes of finished aggregates. It can reject excess sand or produce "stone sand." For concrete aggregate, it will wash all products, or if washed aggregates are not required, it can be used as a dry plant. To save time and money in moving on to the job and between jobs, each unit of the plant is mounted on tracks or wheels. The primary crusher is a Pioneer 30 in. by 42 in. overhead eccentric jaw crusher with welded steel base. Three roll crushers provide ample crushing capacity for any size or requirement.

new products replace more critical materials, such as steel and lumber, in both temporary and permanent structures. The products include a new gypsum exterior siding covered with either smooth or mineral surfaced roofing; laminated gypsum wallboard panels suitable for demountable or permanent single wall interior partitions; laminated gypsum roof deck slabs; and poured gypsum roof decks for use with wood frames in industrial construction.—*The Celotex Corp., 120 S. La Salle St., Chicago, Ill.*

Concrete Vibrator

Model PV238 mall concrete vibrator is equipped with a line strainer and safety throttle. These are high frequency vibrators and are simple in design, all parts being easily removable in the field and no special tools required for the work. There



are no governors in these units to stick and the air consumption is unusually low. The units are designed for concrete of 3-in. slump and over for walls, columns, floors and roof slabs, as well as mass concrete.—*Mall Tool Co., Chicago, Ill.*

Speed Nut for Plywood

Newest speed nut is the No. 6279 developed by Tinnerman Products, Inc. Developed primarily for assembling the plywood parts of airplanes, the nut is useful wherever plywood must be attached to metal or wood, or vice versa. It is designed to be driven instantly into position with a hammer rather than screwed on with a wrench. When the nut is driven over the threads of a screw and into thick plywood, the thread-holding clips snap into place securely, and the four attaching legs spread outward to achieve a spring-tension grip on the wood fibers. When it is driven into thin plywood, which is supported by a vacuum plate, the legs "peen" over automatically for added gripping power.—*Tinnerman Products, Inc., 2038 Fulton Road, Cleveland, Ohio.*

Interceptor

J. A. Zurn Mfg. Co. has developed a wartime model of its plaster interceptor that employs vitreous china for the body and the removable sediment container. Formerly the units were made entirely of

Free! A Sample Pencil

attach this coupon to your business letterhead

EBERHARD FABER PENCIL CO.
37 Greenpoint Ave., Brooklyn, N.Y.

Please send me a_____degree MICROTOMIC "VAN DYKE" with HI-DENSITY Lead.

Name_____

Position_____

Business Address_____

For Tracings You'll be Proud to Initial!

HI-DENSITY Lead will produce tracings of OPACITY beyond your previous experience—and clearer, sharper blueprints. Your drafting skill will immediately perceive the advantages of a MICROTOMIC VAN DYKE Drawing Pencil... and you'll delight in its smoothness, uniformity of grading and notably longer wearing qualities. We suggest you clip the coupon, and investigate HI-DENSITY Lead.

MICROTOMIC
VAN DYKE
DRAWING PENCILS

The Eberhard Faber Drawing Pencil with the MICROTOMIC Lead... 18 Degrees... and 6 also with Chisel Points.

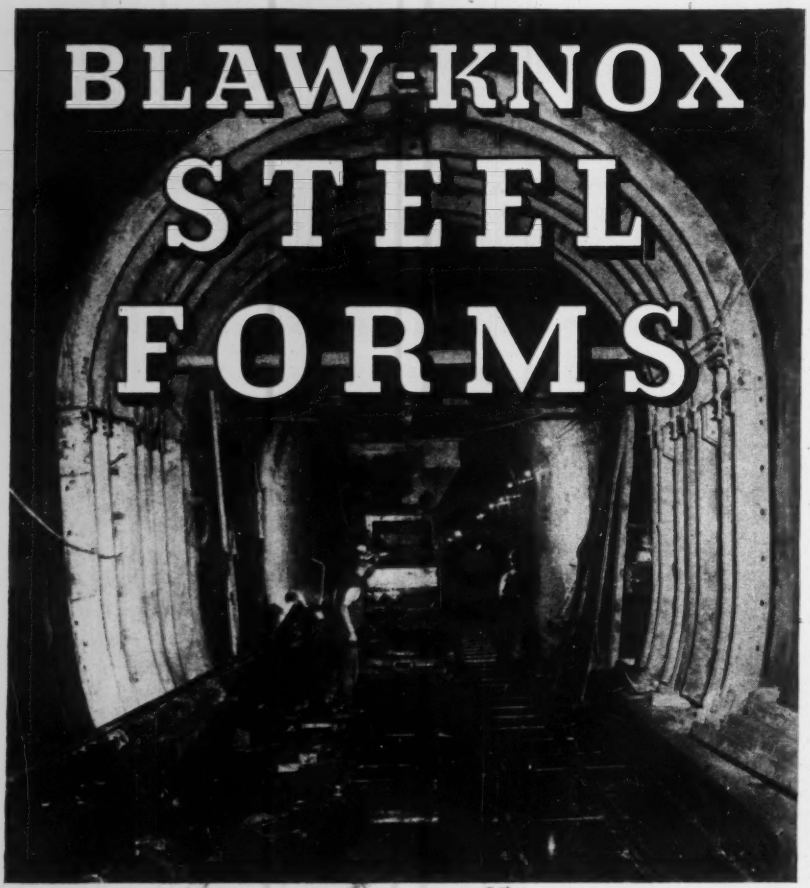
HI-DENSITY LEAD

Ready for your present and future construction planning

Blaw-Knox Steel Forms are designed for speed and economy in construction, and contractors have for many years utilized our specialized engineering service to plan their jobs.

Current construction work of a sufficiently urgent nature can be served, and long range planning for the proper handling of future jobs can be aided by experienced Blaw-Knox engineers.

The engineering facilities and services extended by Blaw-Knox form engineers are prized by all who have taken advantage of them. This service is offered in the interest of engineering progress and is free from any charge or obligation.



BLAW-KNOX STEEL FORMS are used for the construction of
TUNNELS WALLS SEWERS DAMS BRIDGES PIERS
CONDUITS ROADS SEWAGE DISPOSAL PLANTS . . .
. . . and other varieties of concrete construction

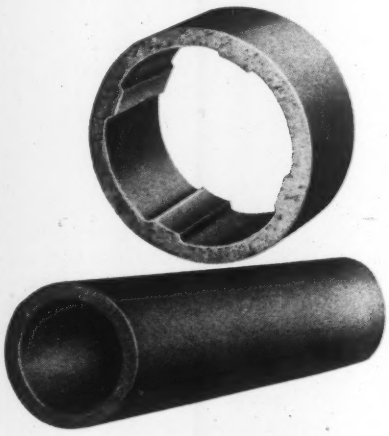
BLAW-KNOX DIVISION of Blaw-Knox Co.
2001 FARMERS BANK BUILDING PITTSBURGH, PA.
NEW YORK • CHICAGO • PHILADELPHIA • BIRMINGHAM • WASHINGTON

metal, including aluminum, cast iron and brass. Metal is now used only for two pipe connections, the perforated metal strainers, and the cover fastening device. The vitreous china employed in the plaster interceptor is fired at a much higher temperature and for a much long-

er period than when intended for less exacting service. This unit is designed to intercept and collect bits of metal, plaster, glass and other solids to prevent clogging of drainage lines in hospitals, dental offices and laboratories, industrial plants, etc. The interceptor can be installed under the sink or fixture it is to serve, or it can be placed on a shelf, set on or in the floor, or other localities.—*J. A. Zurn Mfg. Co., Erie, Pa.*

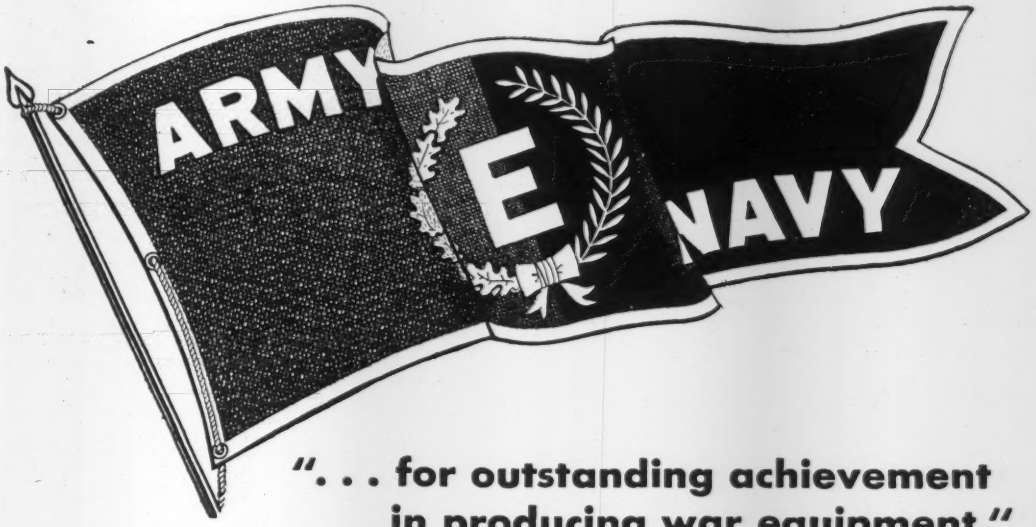
Pipe

Bosco plain end pipe and tru-line collars for airport and highway drainage work are now available. The plain end tile pipes were designed entirely for



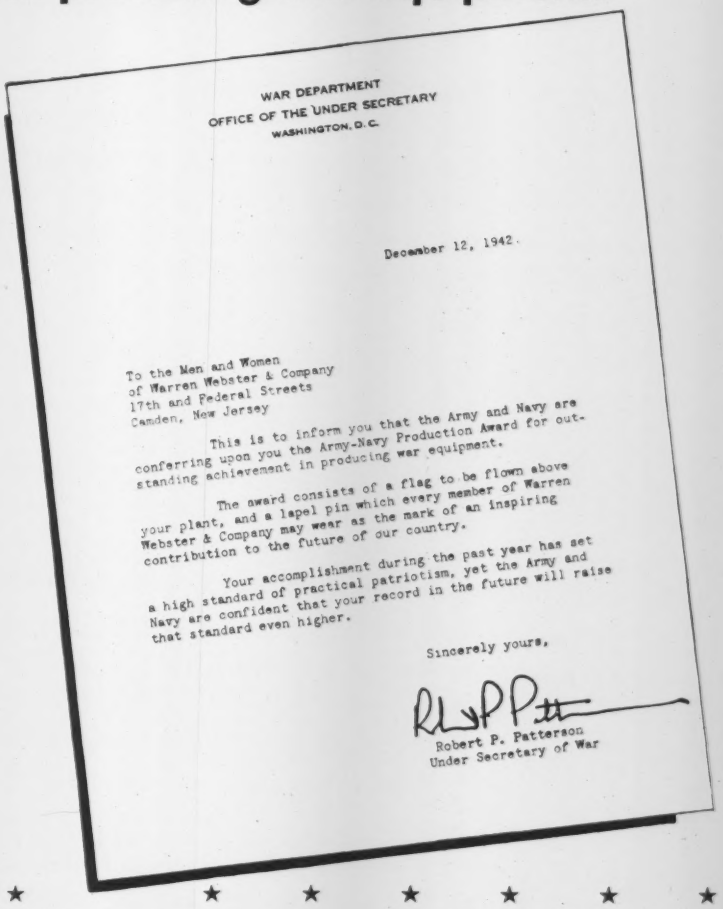
drainage, the collar giving adequate protection at the joint against the entrance of foreign materials and also giving perfect alignment, the manufacturers claim.

HONORING THE MEN AND WOMEN OF WARREN WEBSTER & COMPANY



". . . for outstanding achievement in producing war equipment."

This badge of honor will be worn proudly by every employee of Warren Webster & Company. It is a daily reminder that their production at high rate and quality is urgently needed for Victory . . . production of Ordnance materials for our fighting men . . . production of Webster Steam Heating Equipment for Army and Navy buildings, war plants, ships and other essential uses.



WAR DEPARTMENT
OFFICE OF THE UNDER SECRETARY
WASHINGTON, D.C.

December 12, 1942.

To the Men and Women
of Warren Webster & Company
17th and Federal Streets
Camden, New Jersey

This is to inform you that the Army and Navy are conferring upon you the Army-Navy Production Award for outstanding achievement in producing war equipment.

The award consists of a flag to be flown above your plant, and a lapel pin which every member of Warren Webster & Company may wear as the mark of an inspiring contribution to the future of our country.

Your accomplishment during the past year has set a high standard of practical patriotism, yet the Army and Navy are confident that your record in the future will raise that standard even higher.

Sincerely yours,

Robert P. Patterson
Under Secretary of War

since 1888
Webster
Systems of Steam Heating

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

WARREN WEBSTER & COMPANY, CAMDEN, N. J.

Pioneers of the Vacuum System of Steam Heating, Representatives in principal U. S. Cities

★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★ ★

Design and Gives You These Outstanding Advantages

THE ROTOVALVE design provides these unique advantages because the plug:

lifts, rotates and seats . . . assures through, unobstructed flow . . . provides minimum loss, as the loss through a Rotovalve, when open, is no greater than it is through a pipe of equal diameter and length . . . is obtainable in sizes from 6 to 60 inches, with controls that meet a wide-range of services . . . may be operated manually, hydraulically, or by motor.

Enjoy these advantages, just as modern waterworks and new war-material plants are benefitting by them! Specify ROTOVALVES for your next job—*and be doubly* sure!

S. MORGAN SMITH COMPANY YORK, PENN.

Approved "Dandux" Products

You can save and still buy *quality* when you specify *Dandux*. Precision craftsmanship and finer materials are your definite assurance of an extra measure of service and value in *Dandux* Products.

More than ever, today, we are prepared to do our part toward complete Victory.

C. R. DANIELS, INC.

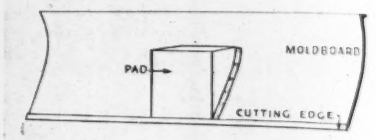
44 West St. New York, N. Y.

Los Angeles • Dallas • Newark • Boston • Buffalo • Chicago
Cincinnati • Cleveland • Detroit • Philadelphia • Pittsburgh

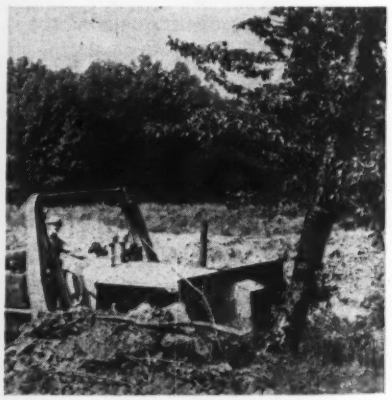
There must be absolute drainage in the landing field of any airport as the successful operations of National Defense programs depend on all year activity. The Bosco plain end pipes with Tru-line collars are made either perforated or plain in sizes 4 in., 6 in. and 8 in. diameter. They are said to more than meet the crushing, absorption and acid solubility of the A.S.T.M. specifications for the bell and spigot type. The pipe are made of vitrefied, de-aired shale and in laying lengths of 2 ft. The ends are smooth so that the flow of the drainage water will not be retarded. Thickness of the barrel of the pipe conforms with A.S.T.M. specifications.—*The Bowerston Shale Co., Bowerston, Ohio.*

Pads for Bulldozer Moldboard

Tree dozer pads developed by engineers of the Baker Manufacturing Co. recently facilitated clearing a stand of timber dur-



ing the construction of an ordnance plant. The pads were designed for bolting to the bulldozer moldboard and can be readily removed when not in use. They can also be used for pushing wheeled scrapers in loading when the going is tough. They were superimposed on the moldboard above the blade, at such an angle as to provide a perpendicular bearing against the back of the scrapers with the moldboard in a raised position. Operators have found these pads ideal for tree dozing, since they place the full tractor power squarely at the center of the blade instead of at either side. The pad is mounted above the cutting edge so that the blade can be replaced without removing or disturbing the latter.—*The Baker Mfg. Co., 567 Stanford Ave., Springfield, Ill.*



Huge airport project 3 months ahead of schedule—

Gulf Lubricants help contractor get maximum performance from equipment and avoid mechanical delays

*Ralph Myers Construction Company, Salem, Indiana, is three months ahead of schedule on a huge military airport project, located in Western Pennsylvania. The $2,500,000 contract involves moving 5,000,000 cubic yards of earth and rock. Gulf quality lubricants are helping this contractor get efficient, trouble-free performance from the many units of modern equipment employed.

"OUR equipment has made an exceptional performance record on this job with Gulf lubricants in service—one of the important reasons we are months ahead of schedule," says airport project contractor.* "Proper lubrication has helped us get the most out of each unit and avoid unnecessary operating delays — which means more dirt moved on every shift."

Now that spare parts and new equipment are so difficult to obtain, many leading contractors use Gulf products as job insurance. For they have learned from experience that Gulf quality lubricants provide an extra margin of protection against breakdowns and mechanical troubles—and that Gulf quality motor fuels help them obtain more efficient performance from their equipment.

You, too, will find it pays to use Gulf quality products on your next contract. They are quickly available to you through more than 1200 warehouses located in 30 states from Maine to New Mexico. Write or 'phone your nearest Gulf office today.

GULF

GULF OIL CORPORATION
GULF REFINING COMPANY
GULF BLDG., PGH., PA.

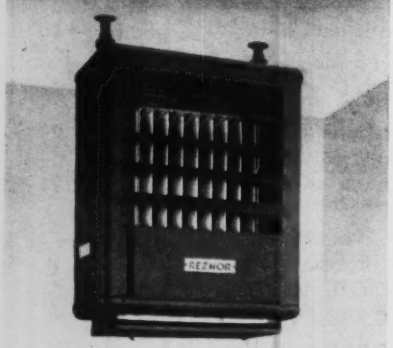
REZNOR

GAS FIRED UNIT HEATERS FOR INDUSTRY . . .

THEY MAY BE INSTALLED QUICKLY AND YOU GET LOTS OF HEAT . . .

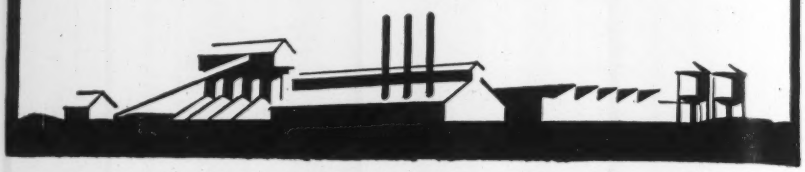
SINCE GAS is used for fuel, Reznor Unit Heaters are self-contained heating plants. You may install this type system more quickly than any other, THUS SAVING 89% IN VITAL, HARD-TO-GET MATERIALS. Operating from a suspended position, Reznor Units deliver more heat over wider areas, due to Reznor's special heat exchanger tubes. Write today.

REZNOR MANUFACTURING CO.
105 James St., Mercer, Penna.



"GAS HEATERS EXCLUSIVELY SINCE 1888"

MANUFACTURERS' ACTIVITIES



Changes involving its district sales offices in Pittsburgh and San Francisco have been announced by the JONES & LAUGHLIN STEEL CORP. CLARENCE C. WEHLING (right) has been appointed district sales manager at Pittsburgh, and R. C. GARVEY has been appointed district sales manager at San Francisco. Mr. Wehling was formerly assistant district sales manager at Pittsburgh, and Mr. Garvey, who succeeds C. P. Hensley — recently retired — has been assistant district manager at San Francisco since 1941. Another change announced by the company includes the appointment of E. S. HOLDEN as resident manager at the Denver sales office, succeeding the late H. H. Galbraith.

O. W. TRUMBULL, formerly of the ASBESTOS TEXTILE CO., is now connected with GREENE, TWEED & Co. of New York, and has been appointed vice president and general manager of that corporation.

The Springfield, Ill., plant of the ALLIS-CHALMERS MFG. CO. was among the first to receive the army-navy "E" award for tractor production, at ceremonies held recently.

Acquisition of the FERBERT-SHORNDORFER Co., industrial paint manufacturers with plant and home office in Cleveland, by the AMERICAN-MARIETTA CO., of Chicago, has been announced. The Ferbert-Shorndorfer Co. will be operated as an American Marietta subsidiary, with DAVID ANDREW, who joined the company in 1930, continuing as its president and GUY BARTHOLOMEW as vice president.

Three army-navy "E" awards were made recently to the plants of FAIRBANKS, MORSE & Co. at Beloit, Wis.; Freeport, Ill.; and Three Rivers, Mich.

DAVID W. HOPKINS, secretary and director of the R-S PRODUCTS CORP., Wayne Junction, Philadelphia, for a number of years, has been elected vice president of that corporation. This announcement followed a recent meeting of the board of directors. Mr. Hopkins will continue in charge of the company's valve division.

CHARLES E. KOHLHEPP, vice president and controller of the WISCONSIN PUBLIC SERVICE CORP. for the last eight years, has been appointed chief of the surplus materials division of the War Production Board.

KENNETH G. CROWL, district freight agent for the PENNSYLVANIA RAILROAD at New Haven, Conn., has been named freight agent in Milwaukee, Wis., succeeding BENJAMIN F. ISENBERG, who was recently promoted to district freight agent at Canton, Ohio.

The JOHN A. ROEBLING'S SONS CO. of Trenton, N. J., recently announced two promotions in its sales department. Promoted were E. G. HARTMANN (right) who became assistant general manager of sales, and DOUGLAS W. VERNON, formerly chief of the priorities division, who was made assistant to the general manager of sales.

Mr. Hartmann's entire business career has been in the steel industry. In 1941, he was promoted from manager of round wire and flat wire specialties division to assist the general manager of sales. Mr. Vernon, an employee of the Roebling Co. for 20 years, entered their service immediately after leaving the University of Chicago.

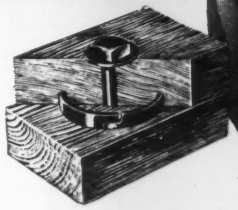
GROWING PLANTS

Selective cutting under scientific woods management has harvested over-age trees and left a healthy, vigorous forest. New seedlings for tomorrow's forest will spring up where sunlight can reach down to the forest floor.

Plants for Industry - Today and Tomorrow

Roof Trusses by Timber Structures, Inc., Portland, Ore.

Engineers, Architects, Designers, Builders in every field of industry now are using engineered timber for heavy duty structures. The TECO Timber Connector System made this possible. You, too, can design in timber with TECO. *Write for our literature today.*



The TECO Ring Connector spreads the load on a timber joint over practically the entire cross-section of the wood . . . brings the full structural strength of lumber into play.

Timber ENGINEERING COMPANY

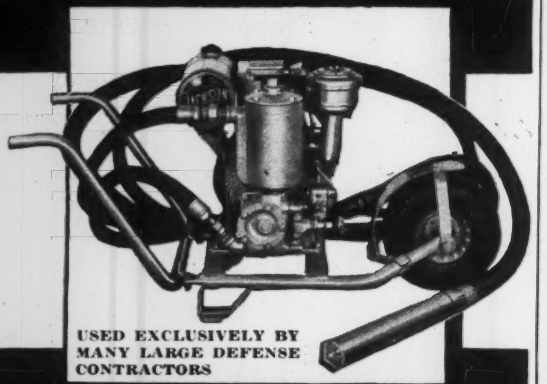
WASHINGTON, D. C. PORTLAND, OREGON

. . . If you want to make speed profitably . . . GET DEPENDABLE EQUIPMENT . . . Buy the Fast . . .

JACKSON Hydraulic Concrete Vibrator

DESIGNED TO "TAKE IT" 3 SHIFTS A DAY—EVERY DAY

- Automatic pressure lubrication—requires no attention.
- 34-ft. hose—2¾" vibrator head.
- Adjustable frequency to 6800 R.P.M.—submerged in concrete.
- Powerful gas engine—4.7 H.P.
- Long-lived, ball-bearing, rotary, hydraulic pump.

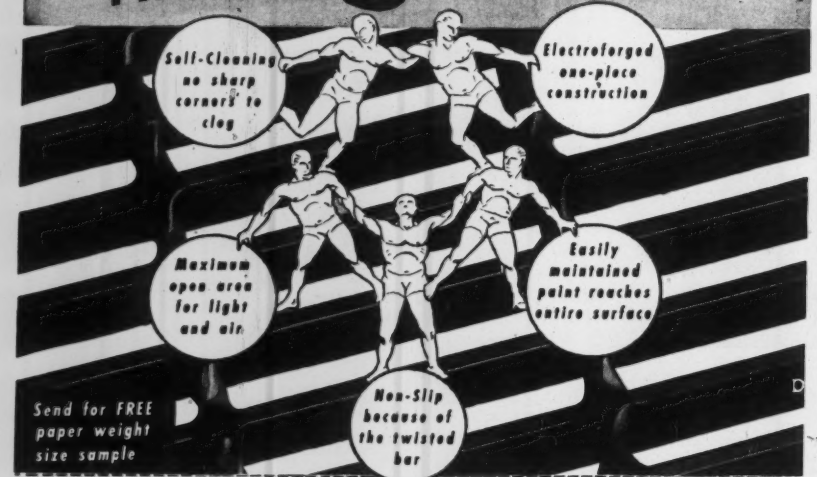


USED EXCLUSIVELY BY MANY LARGE DEFENSE CONTRACTORS

ELECTRIC TAMPER & EQUIPMENT CO.

LUDINGTON, MICHIGAN

BLAW-KNOX GRATING PRESENTS 5 OUTSTANDING FEATURES


Self-Cleaning no sharp corners to clog
Electroforged one-piece construction
Maximum open area for light and air
Easily maintained paint reaches entire surface
Non-Slip because of the twisted bar
Send for FREE paper weight size sample

BLAW-KNOX DIVISION of Blaw-Knox Co.
2001 FARMERS BANK BUILDING · PITTSBURGH, PA.

NAME_____

STREET_____

CITY_____ STATE_____

JOHN R. ROMANN, chief metallurgist of TUBE TURNS, Louisville, Ky., recently was honored by being appointed chairman of a committee to conduct a special nation-wide investigation in industrial plants concerning low temperature properties of metals. This research is being carried on for the War Department by the Metallurgy Committee of the National Research Council, National Academy of Sciences.

The HEIL CO. has announced the opening of a new service brnach at 5743 Woodward Ave., Detroit, Mich., and of a new branch office in Suite 725 Fisher Building, Detroit.

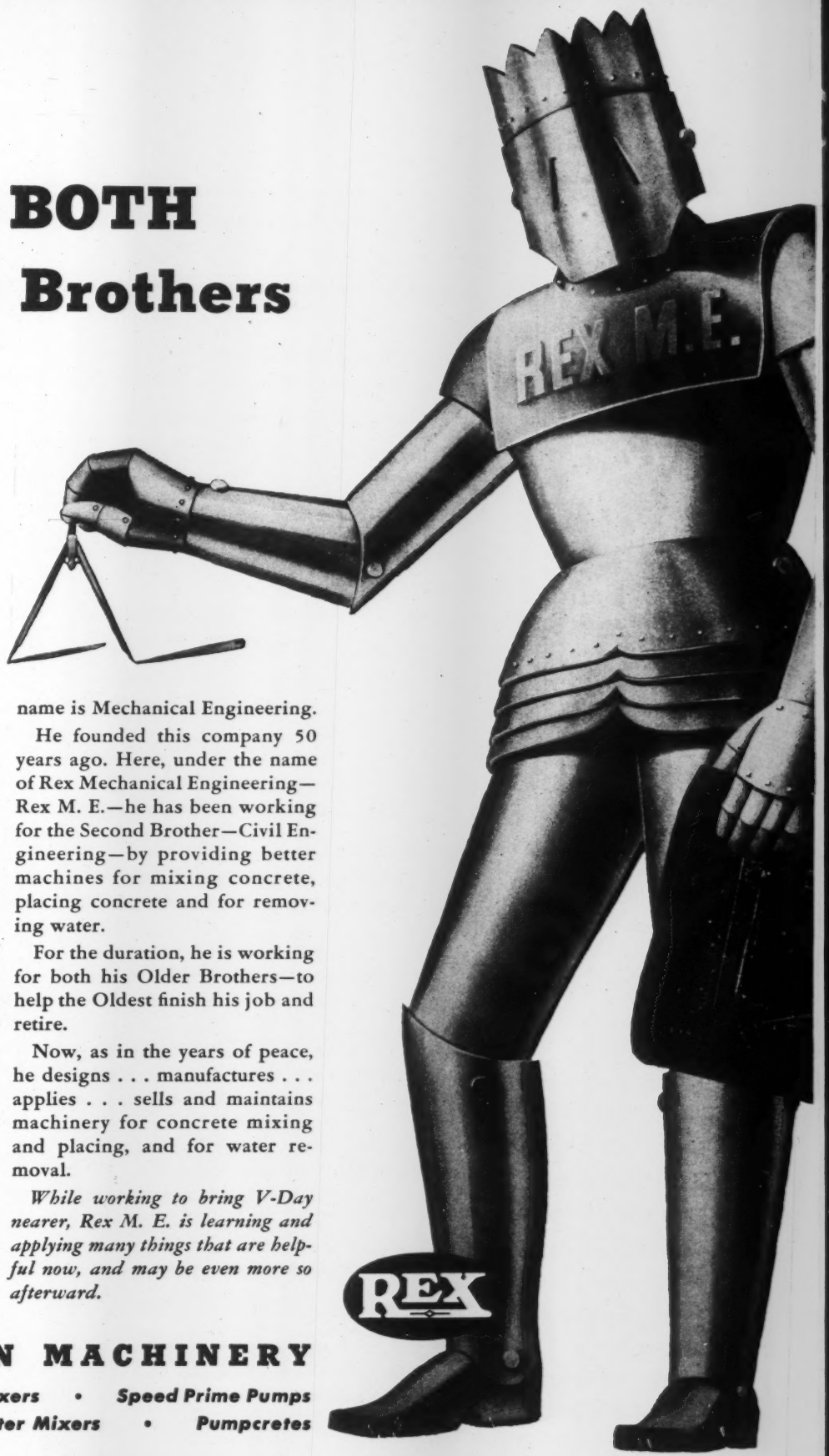
H. W. HEM, well known engineer in the field of weighing, has joined the HOWE SCALE CO. as research director. Mr. Hem was formerly associated with the STRAIT SCALE CO. of Kansas City, Mo., and with the TOLEDO SCALE CO., Toledo, Ohio.

KARL A. NYGREN, formerly general superintendent of the Globe Steel Tubes Co., of Milwaukee, and since 1938 employed by the PITTSBURGH STEEL PRODUCTS CO., of Pittsburgh, as a machinery designer, died suddenly at Eagle Lake, Wis., recently. He was 66.

Robert P. Patterson, Under Secretary of War, announced recently that the Army-Navy "E" production award would be given to the men and women of the CONTINENTAL RUBBER WORKS at Erie, Pa. Formal presentation took place on Jan. 26 at the Roosevelt Junior High School in Erie, Pa.

CHARLES E. MOORE, president of JOSHUA HENDY IRON WORKS, Sunnyvale, Calif., has announced the purchase of the POMONA PUMP CO. of Pomona, Calif., and its recently acquired subsidiary, the WESTCO PUMP DIVISION, St. Louis, Mo. Hendy also purchased the plant and equipment of the HYDRIL CO., Torrance, Calif., to supplement the facilities available at Pomona. The Pomona division will continue to be principally engaged in the manufacture of turbine pumps of the vertical type for all pumping applications. The Westco Division specializes in smaller sizes for domestic and industrial pumping jobs.

He Helps BOTH His Older Brothers



HE BELONGS to a large family of wonder workers.

They are men of faith, who perceive not only the difficulties, but the ways to surmount them.

The Oldest Brother of the family is more active today than ever before. He is over 5,000 years old, but every army drafts him. His name is Military Engineering.

The Second Brother also counts his years by the thousands, although his modern name is not more than 200 years old. His work is with great structures . . . with waterways, railways and highways . . . with lighthouses, harbors and airports. His name is Civil Engineering.

The Third Brother is a youth with only a century or so to his credit. He designs . . . constructs . . . applies, sells and maintains apparatus for generating, transmitting and using power. His name is Mechanical Engineering.

He founded this company 50 years ago. Here, under the name of Rex Mechanical Engineering—Rex M. E.—he has been working for the Second Brother—Civil Engineering—by providing better machines for mixing concrete, placing concrete and for removing water.

For the duration, he is working for both his Older Brothers—to help the Oldest finish his job and retire.

Now, as in the years of peace, he designs . . . manufactures . . . applies . . . sells and maintains machinery for concrete mixing and placing, and for water removal.

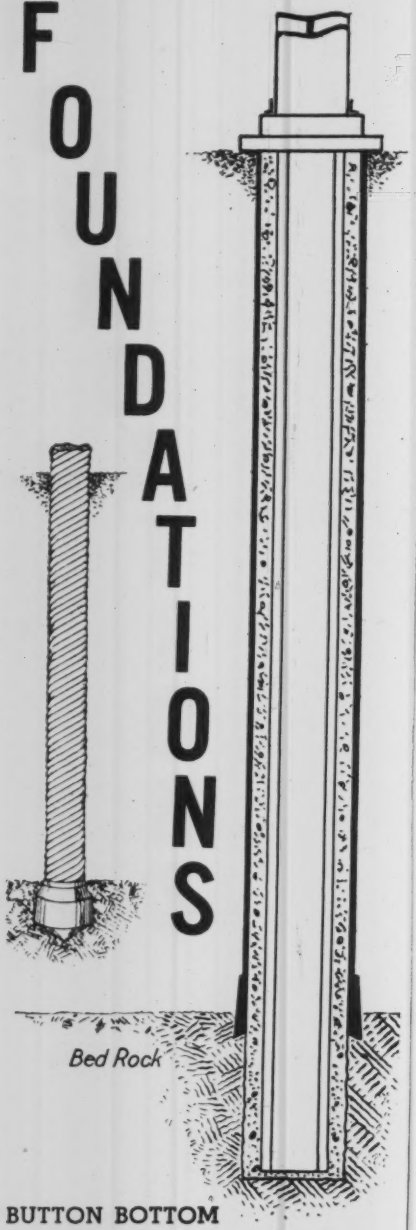
While working to bring V-Day nearer, Rex M. E. is learning and applying many things that are helpful now, and may be even more so afterward.

CONSTRUCTION MACHINERY

Concrete Mixers • Moto-Mixers • Speed Prime Pumps
Pavers • Mortar and Plaster Mixers • Pumpcretes

CHAIN BELT COMPANY OF MILWAUKEE

FOUNDATIONS



BUTTON BOTTOM
COMPOSITE—STEEL PILES
COMPRESSED CONCRETE
CAISSON PILES

DRILLED-IN CAISSONS

Engineers available for consultation on any foundation problem. Catalogues on request.

WESTERN

WESTERN FOUNDATION CO.
WESTERN CONCRETE PILE CORP.

308 W. Washington St. Chicago, Ill.
52 Vanderbilt Ave. New York, N. Y.

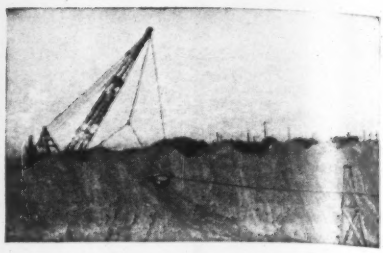
Concrete Forms—Form-Ty Engineering Guide is the title of a new booklet published by Richmond Screw Anchor Co., Inc., to offer a complete volume of information on concrete form work, containing over 106 different types of form-tying devices and accessories, as well as tables, charts, graphs and cost facts said never before to have been published, and is said to be a valuable working tool for all engineers and contractors concerned with concrete work.—*Richmond Screw Anchor Co., Inc., 816 Liberty Ave., Brooklyn, N. Y.*

Tools—A new booklet, which is also a catalog covering tools used extensively in various parts and on jobs for war production has been produced by the Invincible Tool Co. It lists attachments that may be added to standard make tools in order to make close tolerant work easy, shows various combinations of drills and burrs that can be attached to reach hitherto inaccessible machine work and gives blue prints and diagrams in sixteen pages showing how these attachments may be applied and used.—*Invincible Tool Co., 914-916 Citizens Trust Bldg., Fort Wayne, Ind.*

Victory Bulletin—The John W. Stang Corp. has just issued a new Victory Bulletin describing the use of Wellpoint on a diversified number of large construction jobs during the past year.—*John W. Stang Corp., 2 Broadway, New York.*

Heating and Ventilating—The Young "Vertivent" heater and ventilator, designed and developed to meet the many requests for this type of equipment for installation in war production plants, is described in a new catalog, No. 2942 issued by the company. The 4-page folder describes the combination forced air in blackout control units and its installation and uses on war plants.—*Young Radiator Co., Racine, Wis.*

Testing—In one of the handsomest catalogs issued during the past year, Waugh Laboratories have printed a beautifully illustrated, well written book showing the many uses and services offered by the organization and its equipment. Because of the number and variety of standard test instruments, the company claims



Sauerman Scraper, operated by crane, digs basin 400 ft. wide for reservoir.

MOVE MORE YARDS FASTER FOR LESS MONEY

Where loose materials (such as sand, gravel, blasted rock, ore, etc.) must be dug, hauled, and dumped at ranges from 100 to 1500 ft. the economical way to do it is with a SAUERMAN Scraper or Slackline Cableway.

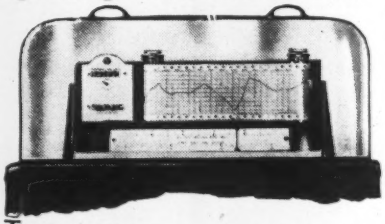
These efficient machines haul 10 to 1,000 tons of material per hour, require only one operator, and demand little in maintenance. SAUERMAN units have made low cost records on dig-and-haul jobs all over the world for 30 years.

Write for Catalog.

SAUERMAN BROS., INC.
532 S. Clinton St., Chicago

SAUERMAN
LONG RANGE MACHINES

60-DAY RECORDS
for use with
Sparling Main-Line Meter



TOTALIZATION by remote control from the Sparling Meter, in any unit desired;

Indication in dual equivalent flow rates;

Recording on a 60-day continuous roll chart with the past 15 hours' record clearly visible. Daily and weekly sections of the chart are readily removable.

Charts and scales are evenly spaced from 3 to 100 per cent of maximum rate.

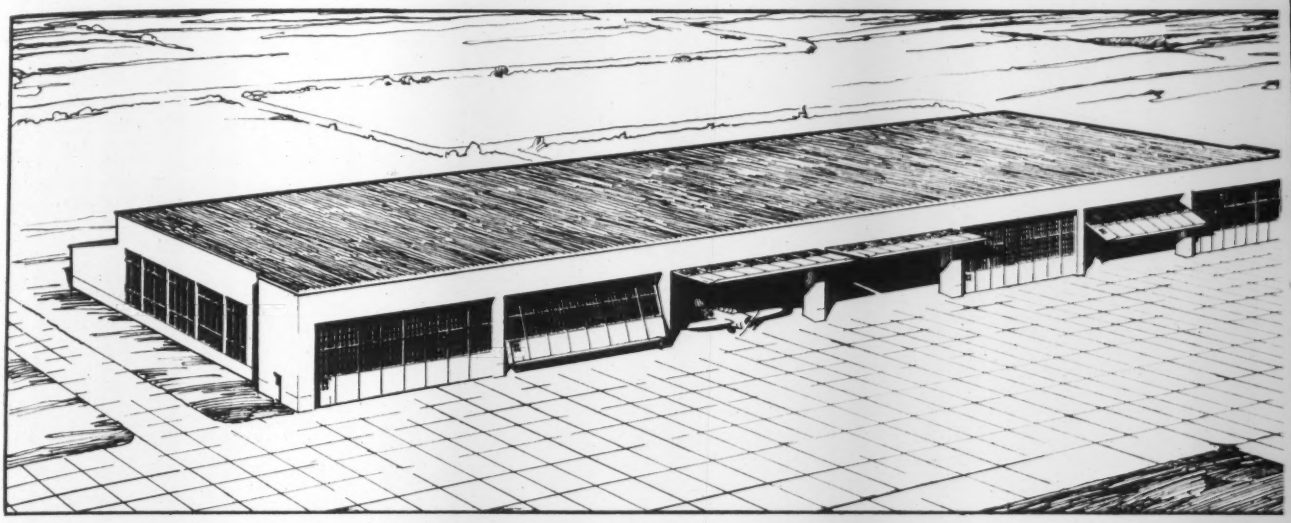
Instrument operates by electric remote control and is available for wall, panel or pedestal mounting. Bulletin 308 will be sent upon request.

SPARLING

3277 Terminal Annex.....LOS ANGELES
3104 Michigan Blvd.....CHICAGO
6 Beacon Street.....BOSTON
622 Broadway.....CINCINNATI
101 Park Ave.....NEW YORK

for Medium-sized Openings

the SPEED, DEPENDABILITY *and* ECONOMY *of* BYRNE canopy doors



Part of an aviation training school in which 21 Byrne canopy doors, 50 by 20 feet, are being used.

To hangar doors of medium size, Byrne brings all of the advantages which Byrne Canopy Doors have long provided for huge openings: *high-speed operation, trouble-free performance, minimum operating power, reduced heat losses, low-cost maintenance* and *substantial savings in useful floor space.*

Cooperation in the design of hangar doors of any size or any type will be gladly extended by Byrne Engineers.

BYRNE doors

incorporated

1150 Griswold St. Detroit, Mich.

Cable Address: BYRNDOR

SEE OUR CATALOG IN SWEET'S

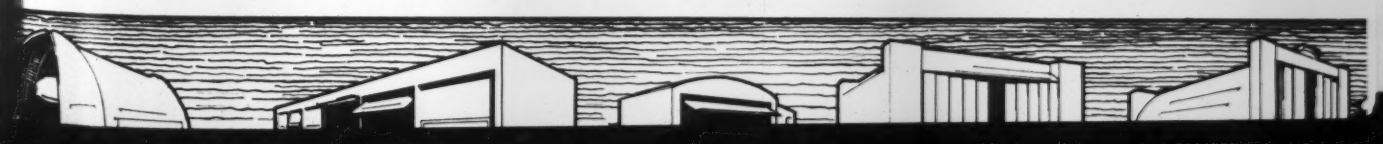
BRANCH OFFICES:

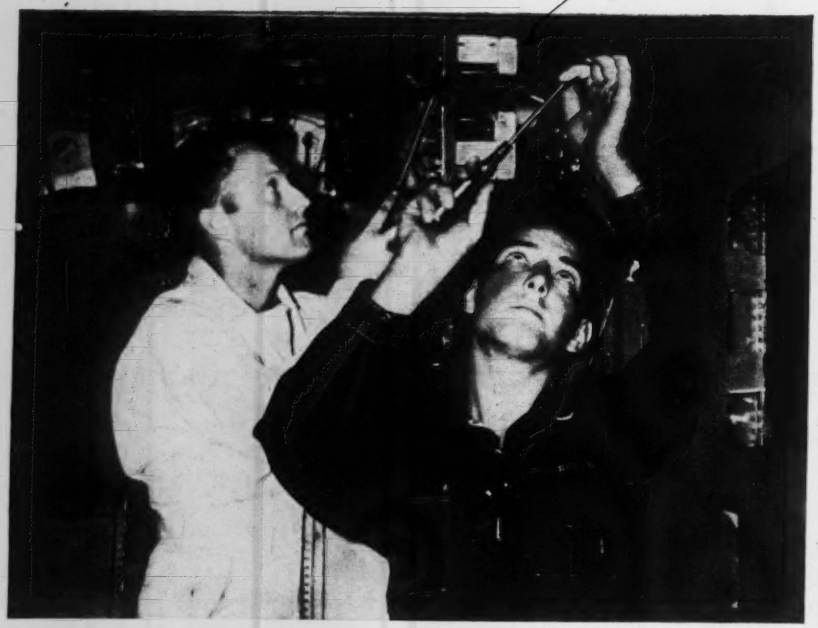
WASHINGTON, D. C. 1092 National Press Bldg.

SAN FRANCISCO, CALIF. Builders Exchange

NEW YORK, N. Y. 101 Park Avenue

BYRNE MOTORIZED DOORS FOR EVERY HANGAR TYPE





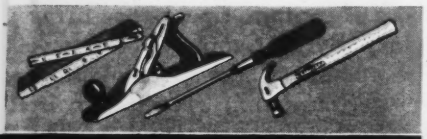
Photo—Courtesy Collier's

TOOLS *to build Airplanes*

The swarms of airplanes needed to speed the doom of the Axis could never be built nor serviced without *hand tools*—hammers, screw drivers, planes, breast drills, chisels—the same types of hand tools you use on the job every day. Stanley Tools are being used in tremendous quantities by airplane plants, air bases and training fields, carriers, and by every flying field on the many distant fighting fronts.

Because of this demand, tools for normal use are necessarily scarce. Buy them only for Essential use. Stanley Tools, Division of The Stanley Works, New Britain, Connecticut.

1843 STANLEY 1943



STANLEY TOOLS

"The Tool Box of the World"

TIME-TESTED JOINTING COMPOUND
for Bell and Spigot Water Mains

10 REASONS FOR USING

1. One lb. HYDRO-TITE equals 4 lbs. lead.
2. Stands any pressure the pipe can.
3. Joints showing seepage will take up.
4. Requires no calking so speeds job.
5. Anyone can make tight joints.
6. Permanent as the pipe itself.
7. Stands deflection and vibration.
8. 30 years without a failure.
9. Shipped promptly.
10. Demonstration without charge.

***Write for* JOINTING BOOK**

HYDRAULIC DEVELOPMENT CORP.

50 CHURCH STREET — NEW YORK, N. Y.

that an engineer seldom is equipped with an instrument in the range which is available and essential for properly testing materials before incorporating them in structures. Waugh Laboratories has this equipment and offers a service said to be unique in the field of testing since it makes available at a single source both an engineering field service and the instruments needed in conducting tests. After a general introduction which shows some of the many fields in which the organization offers services, the booklet describes measuring of induced vibration forces, vibration and noise measuring machinery, strain measuring, measuring of load forces and shocks, measuring of time, space and movement, heavy castings and many other fields.—*Waugh Laboratories, 420 Lexington Ave., New York.*

Welding Accessories—"Arc Welding Accessories for Women" is the title of an attractive new bulletin issued by the Industrial Department of the General Electric Co. The bulletin, illustrated throughout, presents General Electric's complete line of safety clothing and equipment especially designed for increasing numbers of girl welding operators.—*General Electric Co., Schenectady, N. Y.*

Alkali—Buyers of alkali products now have available a new 30-page Solvay Products Book. The book is well organized for ready reference and gives specific information on forms and the chemical and physical properties of Solvay products and their uses. In addition to product information, there are short chapters on safety methods, dissolving caustic soda and caustic potash and how to utilize Solvay Technical Service.—*Solvay Sales Corp., 40 Rector St., New York, N. Y.*

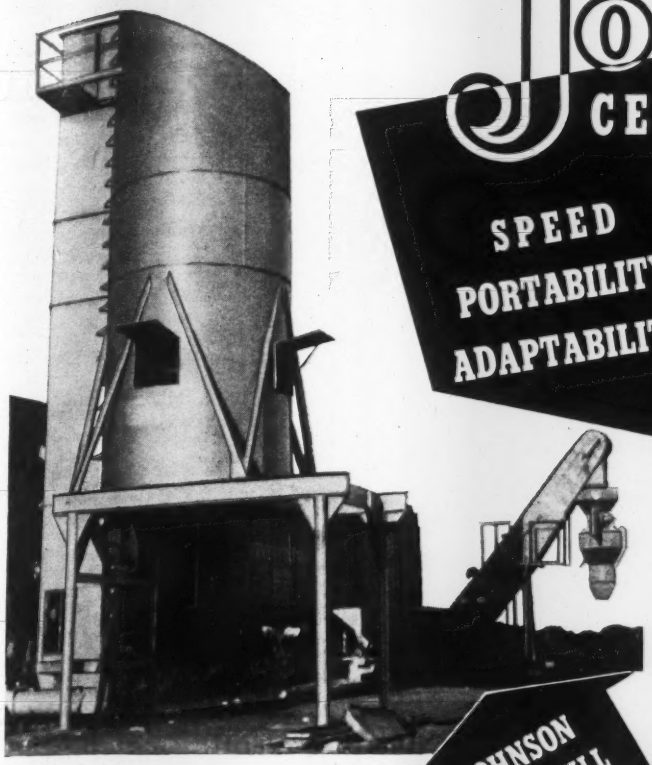
Control Instruments—The Bristol Co. has published a series of bulletins covering automatic control and recording instruments for industrial furnaces, dryers, kilns and ovens. These have been bound together in loose-leaf form in order that additions and revisions may be easily inserted. The binder set covers pyrometer recorders and controllers, thermometer recorders and controllers, humidity recorders and controllers, draft controllers, control valves and accessories.—*The Bristol Co., Waterbury, Conn.*

Etching Stamp—A new bulletin illustrating and describing a new type of etching stamp recently developed has been issued by Jas. H. Matthews & Co. The material used in the new stamp is designated as "S-22" synthetic—which is said to be unaffected by acid etching fluid.—*Jas. H. Matthews & Co., 3942 Forbes St., Pittsburgh, Pa.*

JOHNSON CEMENT PLANTS

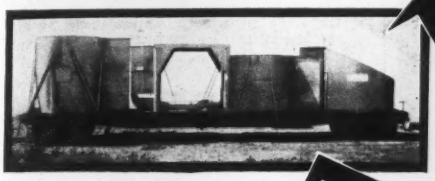
SPEED
PORTABILITY
ADAPTABILITY

NOW! MORE IMPORTANT THAN EVER BEFORE—time and labor saving features, fast efficient operation, and adaptability to any construction need or situation must be present in all construction equipment.



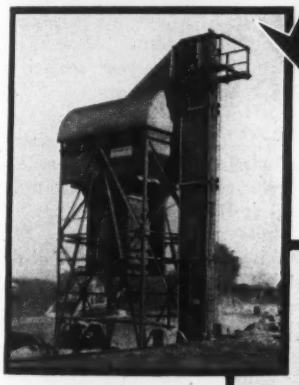
- ★ Only two men needed on Johnson cement plants—with hopper-bottom car or bulk truck cement delivery.
- ★ 120 batches or 200 barrels of cement can be batched per hour through any Johnson Cement Plant with manual control.
- ★ Bulk trucks, truck mixers, or both can be charged through Johnson Cement Plants.
- ★ Johnson Cement Plants are adaptable for box car, hopper bottom car or bulk truck cement delivery.
- ★ All Johnson Cement Plants are quickly and easily convertible from batching plants to transfer plants or vice versa. Transfer plants have 250 barrel per hour capacity.
- ★ Johnson Cement Plants are really portable—Elevating Charger, Dutchmill and Portable Section Cement Bins can be completely erected or dismantled by three men in two hours' time.
- ★ Elevating Charger is economical with bag cement—elimination of split sacking and much labor, plus faster batching time for both batch trucks or truck mixers are possible.

JOHNSON DUTCHMILL

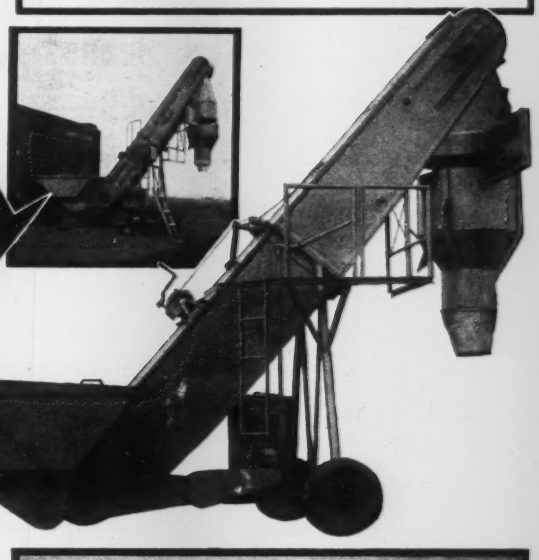


JOHNSON CEMENT PLANTS MEET ALL REQUIREMENTS AND THEN SOME

PORTABLE SECTION BINS AND CEMENT SILOS



ELEVATING CEMENT CHARGER



JOHNSON CEMENT PLANTS ARE AVAILABLE WITH CEMENT STORAGE CAPACITY FROM 25 TO 7000 BARRELS.

CHAMPAIGN ★ C. S. JOHNSON CO. ★ ILLINOIS

KERLOW

Why War Plants Need KERLOW open STEEL FLOORING

Today, the advantages of Kerlow Open Steel Flooring are more important to industrial plants than ever before. Here are five reasons why: 1. Safety . . . open-mesh, non-skid design reduces accidents. 2. Light . . . as 85% of floor area is open, there is ample passage for light. 3. Ventilation . . . air, fumes, heat and ordors pass through floor openings readily. 4. Permanence . . . will outlast any other type of floor. 5. Economy . . . first cost is low, installation is simple and only maintenance expense is occasional repainting.

FREE BULLETIN Write for your copy today

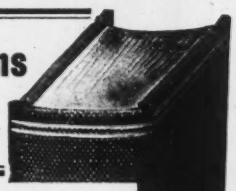
KERLOW STEEL FLOORING CO., 23 Mallory Ave., Jersey City N. J.

Make Every Pay Day a Bond Day

Buy U. S. War Bonds and Stamps

KERLOW RETICULATED DESIGN ...A PATTERN FOR VICTORY

Get help in passing license exams from this practical book—



Here is a compact, handy manual, by two well-known engineering writers, that meets all needs for quick review of, or reference to, the most important elements of designing simple structures of special value to those preparing for license or registration exams.

ELEMENTARY STRUCTURAL ENGINEERING

By L. C. Urquhart and C. E. O'Rourke, Professors of Structural Engineering, Cornell University, 348 pages, illustrated, $3.00.

Use this book for quick check-up and reference on design fundamentals, procedures and calculations for simple steel, timber, and concrete members and connections. It gives you 1) helpful groundwork in the principles of structural mechanics; 2) useful thumb-nail review of materials; 3) requirements of loads for various types of structures; 4) methods of computing deflections of beams and trusses; 5) design treatment of such structural members as homogeneous beams, plate girders, reinforced concrete beams, tension and compression members in trusses, columns, members, and footings.

EXAMINE IT 10 DAYS——SEND THE ON-APPROVAL COUPON

McGRAW-HILL BOOK CO., INC., 330 W. 42nd St., N. Y. C.

Send me Urquhart and O'Rourke—Elementary Structural Engineering for 10 days' examination on approval. In 10 days I will send $3.00, plus few cents postage, or return book postpaid. (Postage paid on orders accompanied by remittance.)

Name .....

Address ..... Position .....

City and State ..... Company ..... NR. 1-28-43

MEN AND JOBS

Earl Harbeck, assistant engineer and office manager for the U. S. Geological Survey at Murphy, N. C., has been commissioned a first lieutenant in the Marine Corps.

Robin Swift of Atmore, Ala., has been appointed state highway director for Alabama.

Albert Raver, assistant county engineer of Green county, Iowa, has been named county engineer during the absence of **C. Arthur Elliott,** who recently joined the Corps of Engineers.

Ralph Burch, of Cedar Rapids, Iowa, has accepted a post as a construction engineer on an airport in Kentucky.

R. de Charms, Jr., has been promoted from the rank of lieutenant commander to that of commander, CEC, USNR, and public works officer and officer in charge of construction at a Marine Corps air station in South Carolina.

Aimé Cousineau, sanitary engineer in the service of the Montreal city health department, has been appointed director of the city planning department, replacing the late H. A. Terreault.

Eugene T. Cudworth, chief of the drafting section of the hydrographic office of the Navy at Suitland, Md., retired recently after 40 years of service as a civilian employee of the government. He was engaged in hydrographic survey operations in southern waters before he became chief of the drafting section, a position he held for 20 years.

J. T. Dwyer, Little Rock, Ark. engineer, is head of a party that recently made a preliminary survey for an airport to be constructed at Hot Springs, Ark.

George R. Bickel, vice president of the Henry Bickel Co., construction engineers, of Louisville, Ky., has been elected a director of the Louisville Board of Trade.

Willis J. Spaulding, for many years commissioner of public properties for the city of Springfield, Ill., recently announced his candidacy for reelection for his ninth successive term.

•

Roy Baxter has been named superintendent of the sewage disposal plant at Anderson, Ind., succeeding **Paul Laux** who recently was promoted to the superintendency of the municipal water plant.

Arthur Frick has been appointed assist-

Why PREforming Conserves Steel, Makes Wire Rope Last Longer

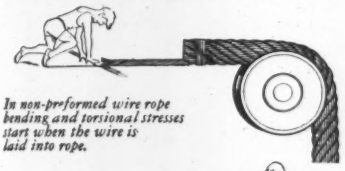
(Note: More and more wire rope users change to PREformed rope each year. During peacetime the reasons for changing from ordinary to PREformed wire rope were primarily two: the cost is lower; PREformed is easier to handle.

Today, with our nation at war and with steel at a premium, there is another and most important reason for using PREformed. It lasts much longer under high speed, severe bending and continuous operation. PREforming thus conserves steel. It conserves workmen's time; rope changes are less frequent. It reduces the accident potential; there is no wickering to harm hands or damage sheaves.)

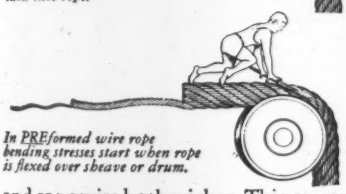
There are two kinds of wire rope. One is called Regular, or ordinary, wire rope. The other is known as PREformed.

In ordinary rope wires are held together under tension. The wires are laid into the rope by bending them to the desired shape. Bending and torsional stresses thus remain in the rope . . . are kept under control by seizing the ends of the rope.

If the wire breaks, it immediately wickers. If the seizing breaks, the strands



In non-preformed wire rope bending and torsional stresses start when the wire is laid into rope.



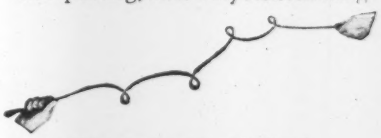
In PREformed wire rope bending stresses start when rope is flexed over sheave or drum.

and rope wire both wicker. This causes damage and delay. In PREformed wire rope, the strands and wires are preshaped to the exact curvature they will take in the finished rope. Bending and torsional stresses are eliminated (except of course when the rope bends over a sheave). If a wire breaks, it does not wicker but remains relaxed, thus causing no delay or damage.

Advantages of PREforming

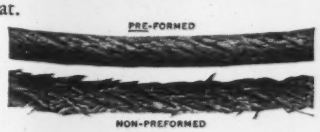
PREformed wire ropes are like shoes that have been broken in. Instead of being stiff and unwieldy, they are flexible, easier to handle.

They are better adapted to bending and spooling, also. They resist kinking



when the rope is not under load.

PREformed wire ropes are easier to handle also because broken wires lay flat.



And finally, most important, PREformed wire ropes have greater resistance to bending and fatigue. This is

another way of saying that they last much longer, do a better job when the pressure is on, as it is today in war production.

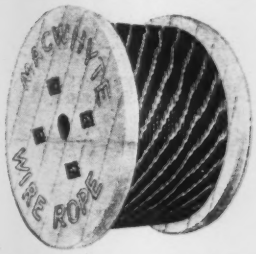
When next you need wire rope, consider seriously the purchase of PREformed wire rope. Today the job we must all do is the "best" job possible. When it comes to wire rope there is no question as to which does the "best" job. It's PREformed.

Consult with Macwhyte

Don't overlook the help that Macwhyte engineers will gladly give you on any wire rope problem. Their advice gained from many years' work on all kinds of jobs is yours for the asking. Let us know the kind of work to be done; we will tell you the rope best suited for the job.

And this we urge you to do: take extra care of your present ropes. Inspect them regularly; lubricate them often. By so doing you can make them last longer and thus aid the war effort. That's what you want; that's what your country asks of you.

This is Number 13 in a series of informative articles prepared by the Macwhyte Company to help wire rope users obtain better and longer service from ropes on the job. All articles in this series are available on request.



MONARCH Whyte Strand PRE-FORMED WIRE ROPE

. . . Macwhyte premier wire rope, famous for its strength, toughness, and internal lubrication.

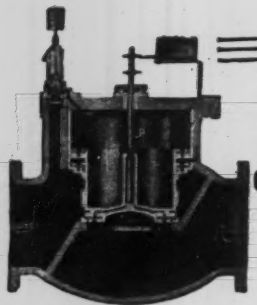
NO. 652

MACWHYTE COMPANY

WIRE ROPE

2940 FOURTEENTH AVE. KENOSHA, WISCONSIN

Manufacturers of MACWHYTE PREformed and Internally Lubricated Wire Rope MONARCH WHYTE STRAND Wire Rope
MACWHYTE Special Traction Elevator Cable MACWHYTE Braided Wire Rope Slings MACWHYTE Aircraft Cables and Tie-Rods



ELECTRIC DOUBLE CUSHIONED CHECK VALVE

★

This valve is for use in connection with remote tank storage service with valve located adjacent to motor centrifugal pump, also where a high-low pressure or float-operated switch located at tank is wired to the valve in order to accomplish complete automatic sequence of operation for starting and stopping the pump with respect to storage water levels.

Sizes 3" to 36", angle and globe patterns.

Write for Specifications

GOLDEN-ANDERSON VALVE SPECIALTY CO.
Fulton Building Pittsburgh, Pa.

GRIFFIN

GRIFFIN

WELLPOINT SYSTEMS

JETTING PUMPS

FOR SALE RENT

Prompt Shipments

Send for our New 60 page illustrated catalog

"GRIFFIN POINTED WELLPOINT FACTS" chock full of latest information on Wellpoint Systems for dewatering, emergency and permanent water supply systems, also information on pressure pumps and data for jetting.

GRIFFIN WELLPOINT CORP.
881 EAST 141st ST. • NEW YORK, N. Y.
Phones: MElrose 5-7704-5-6

ant chief engineer of power plants for Milwaukee, Wis., water plant.

Capt. Harold B. Gotaas, chief engineer, division of health and sanitation, Coordinator of Inter-American Affairs, recently left this country to visit and work on the sanitation program in Latin American countries.

Charles L. Senn, assistant chief engineer in charge of sanitary inspection for the Milwaukee, Wis., health department, has been appointed public health engineer for Los Angeles, Calif.

Louis A. Geupel, of Evansville, Ind., has been elected chairman of the State Board of Registration for Engineers and Land Surveyors.

Col. Harold E. Schlesinger has been named post engineer at a new Army camp just activated in North Carolina.

Wesly P. Bliffert of Milwaukee, Wis., has been commissioned a lieutenant, (j.r.), in the naval civil engineering corps.

Henry Crown, formerly chairman of the board of the Material Service Corp., of Chicago, Ill., has been commissioned a lieutenant colonel in the Corps of Engineers.

James C. Moore, of Waynesville, N. C., has joined the Corps of Engineers in a civilian capacity to do special construction work.

R. W. Ackerman, superintendent of construction on supplementary roads for the Missouri State Highway Department, has been commissioned a first lieutenant in the Corps of Engineers.

Col. Benjamin B. Talley, in charge of Army construction work in Alaska under the Alaska Defense Command, has been awarded the Distinguished Service Medal for "exceptionally meritorious and distinguished service as area engineer and as officer Alaska construction."

D. M. Faires, of Coeur d'Alene, Idaho, has been named a district engineer for the Idaho State Highway Department, succeeding **E. W. Swan,** who has been given a special maintenance assignment.

Joe Wolford has been appointed county engineer of Lincoln County, Kan., succeeding **R. R. Ballou** who recently took a leave of absence to do war work.

C. W. Klassen, chief sanitary engineer of the Illinois State Department of Public Health at Springfield, has been commissioned a captain in the sanitary engineering corps of the U. S. Army, and has reported to Carlyle, Pa., for training.

How to get smoother, harder surfaces . . .

Celotex Absorptive Form Liner Removes Excess Water, Air

This unretouched photograph clearly shows the difference between concrete surfaces poured against Celotex Absorptive Form Liner and surfaces poured against other forms. By removing excess water and trapped air, this produces a smooth, dense, hard outer layer.

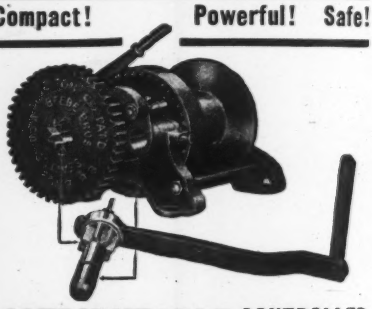
Better appearance, greater durability and resistance to abrasion are among the important results. Successfully used on many government projects, including dams, aqueducts, bridge piers, etc. Write for information.

CELOTEX

ROOFING • INSULATING BOARD
ROCK WOOL • GYPSUM WALLBOARD • LATH
PLASTER • ACOUSTICAL PRODUCTS

THE CELOTEX CORPORATION • CHICAGO

Compact! Powerful! Safe!



DISTRIBUTABLE CONTROLLED POWER

with ALL STEEL HAND HOIST Bros.
SEATTLE, U.S.A.

★

Money Has Been Saved on These Jobs

1200' assembled pipe (132 Tons) were lowered to bed of Mississippi at St. Paul with 9—5-Ton Beebes, three lines to each hoist through blocks.

Hudson River Bridge sidewalks were laid in sections with 32—5-Ton Beebes.

Longest wooden trusses in world were installed with ONE 5-Ton Beebe after power hoists proved impractical.

★

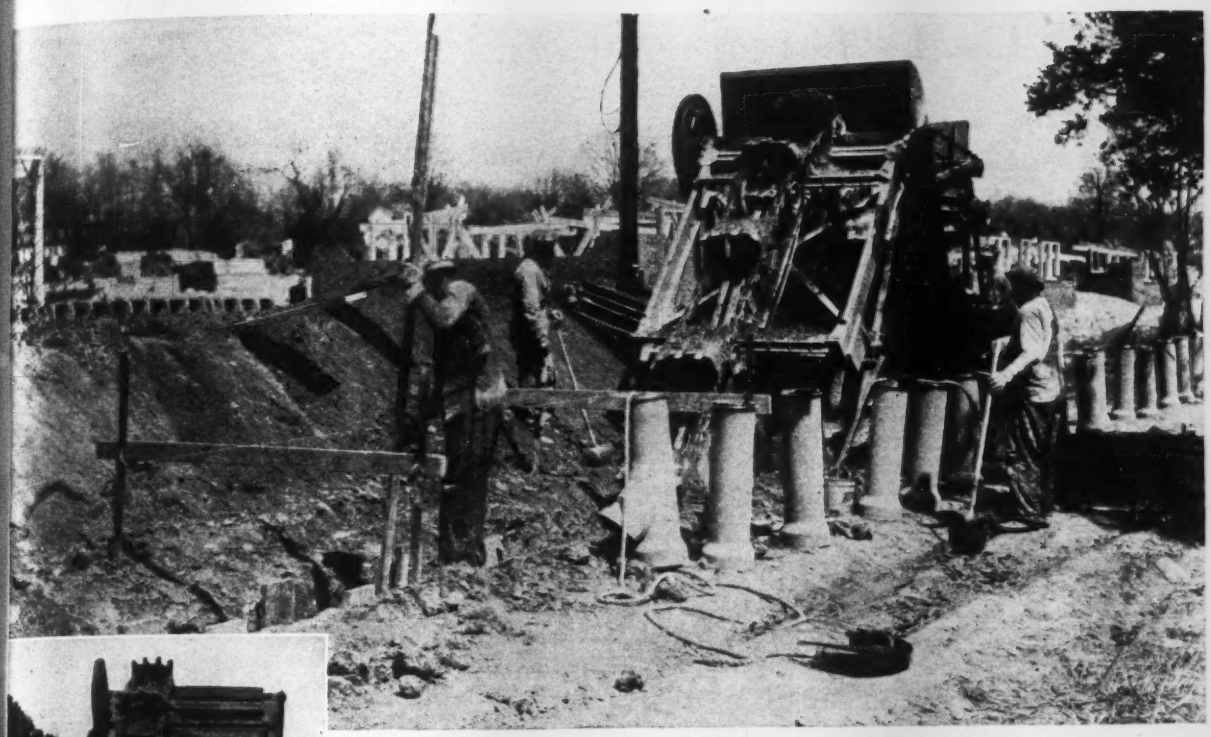
When raising, lowering, or placing costs by power are a serious problem, the answer is the right number of Beebe Bros. All Steel Hand Hoists MANNED IN UNISON. Available in 2, 5 and 15 Ton sizes. Sold through leading dealers in all trade centers. List of dealers sent upon request.

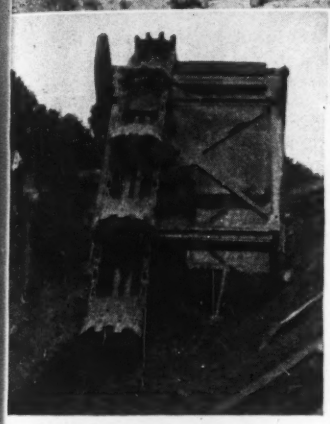
BEEBE BROS., 2720 6th Ave. S., Seattle, U.S.A.

★

"THE STRONGEST GEARED POWER FOR ITS WEIGHT IN THE WORLD"

PARSONS





Parsons Trencher cutting ditch between pavement edge and steep bank. Only an offset boom could work in these restricted quarters successfully.

TRENCHERS Set Pace for Housing Projects

Parsons' speed and dependability made them first in the field when cantonments, airports and ordnance plants were constructed. And now Parsons Trenchers continue to set the pace in housing jobs throughout the country. Sewer, water, gas and electrical distribution systems must be completed first before homes can be built. Only because these machines are compactly built with alloy steels, anti-friction bearings and enclosed hardened gearing can uninterrupted, profitable operation continue. The original Parsons' patent — Offset Boom — permits excavations in narrow alleys or on road shoulders, making trenching possibilities unlimited. Speed and profit are easily available on housing projects with a Parsons Trencher.

SEE YOUR NEAREST DEALER TODAY.

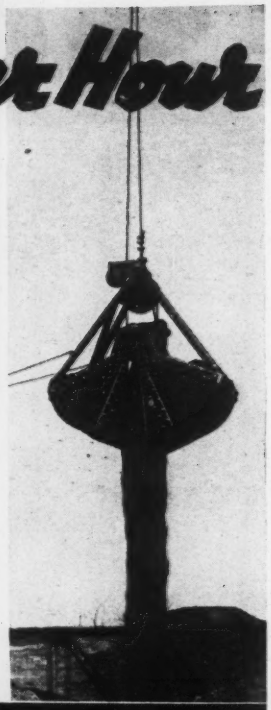
THE PARSONS COMPANY • NEWTON, IOWA

TRENCHING EQUIPMENT

PARSONS

Move Tons per Hour

WITH AN I. B. BUCKET

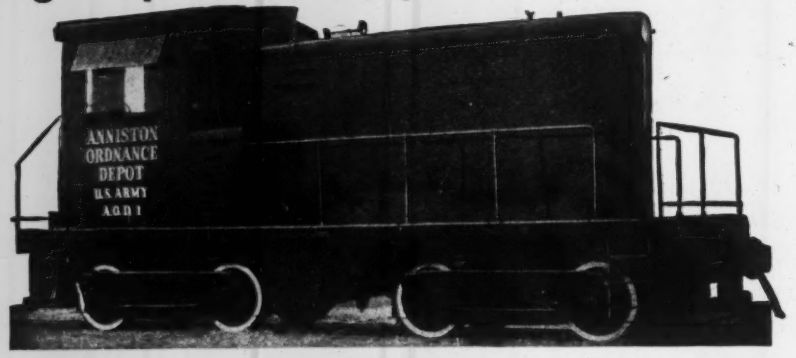


Properly designed—as a result of over 50 years experience—Industrial Brownhoist buckets are light in weight yet of extra sturdy construction. Large sheaves reduce rope wear and maintenance to a minimum. Deep clean bites practically eliminate hand shoveling. Standard types (rope-reeve, power-wheel, link-type) in stock for immediate delivery. Write for complete information.

INDUSTRIAL BROWNHOIST

BAY CITY, MICH. • DISTRICT OFFICES: NEW YORK, PHILADELPHIA, PITTSBURGH, CLEVELAND, CHICAGO

Dig Deep! Look Sharp! Find More SCRAP!



DAVENPORT LOCOMOTIVES

No matter how much SCRAP you've made available to Uncle Sam to date, KEEP RIGHT ON! The need for SCRAP is URGENT. Make EVERY DAY a Salvage Day. Mounting war production demands more and more SCRAP. There's a big job—a grim job to be done. Round up every bit of metal you can spare and start it on its way to the Steel Mills—NOW! TODAY!—and EVERY DAY!

UNCLE SAM NEEDS ALL OF YOUR SCRAP NOW!

STEAM-GASOLINE-DIESEL LOCOMOTIVES ELECTRIC OR MECHANICAL DRIVE

EXPORT OFFICE **BROWN & SITES** 50 Church St., N. Y. Cable Add. "Brosites"

DAVENPORT LOCOMOTIVE WORKS

A DIVISION OF DAVENPORT BESLER CORPORATION, DAVENPORT, IOWA

MEETINGS

ENGINEERING INSTITUTE OF CANADA, 57th annual general meeting, Royal York Hotel, Toronto, Canada, Feb. 11-12.

AMERICAN CONCRETE INSTITUTE, 39th annual convention, Palmer House, Chicago, Ill. Feb. 17 only.

AMERICAN SOCIETY FOR TESTING MATERIALS, spring meeting, Hotel Statler, Buffalo, N. Y., week of March 1.

REGIONAL AND LOCAL MEETINGS

SOUTHWESTERN LUMBERMAN'S ASSOCIATION, "Victory Merchandising Clinic," Des Moines, Iowa, Feb. 4-5.

CONSTRUCTORS ASSOCIATION OF WESTERN PENNSYLVANIA, 9th annual meeting and dinner, William Penn Hotel, Pittsburgh, Pa., Feb. 4.

MICHIGAN HIGHWAY ENGINEERING CONFERENCE, annual meeting, Michigan Union, Ann Arbor, Mich., Feb. 10-12.

NEW YORK STATE COUNTY HIGHWAY SUPERINTENDENTS ASSOCIATION, annual meeting, Albany, N. Y., Feb. 11-12.

OHIO SOCIETY OF PROFESSIONAL ENGINEERS, 64th annual convention, Deschler Wallick Hotel, Columbus, Ohio, Feb. 11-12.

SOUTHEASTERN ASSOCIATION OF STATE HIGHWAY OFFICIALS, Chattanooga, Tenn., Feb. 16-17.

ASSOCIATION OF HIGHWAY OFFICIALS OF NORTH ATLANTIC STATES, Highway Problems Conference, Hotel Pennsylvania, New York, N. Y., Feb. 17-19, 1943.

UNIVERSITY OF UTAH, 4TH ANNUAL HIGHWAY CONFERENCE, Salt Lake City, March 1-2.

SOUTHERN SAFETY CONFERENCE, 5th annual meeting, Hotel Peabody, Memphis, Tenn., March 1-2.

NEW JERSEY SEWAGE WORKS ASSOCIATION, war conference, Stacy-Trent Hotel, Trenton, N. J., March 25-26.

Elections and Activities

WARTIME and post-war construction problems were studied by about 500 members of the Associated General Contractors of Minnesota at a three-day war construction conference held at St. Paul Jan. 21-22-23. Discussion dealt with specific problems such as war construction, truck conservation, government regula-

Durable CONCRETE ROADS
–a vital wartime asset

In these times it is good to know that 100,000 miles of concrete roads are on the job.

Maintenance funds go an average of THREE TIMES AS FAR on concrete as on the next most commonly used state road surface.

This saving means the conservation of millions of man-hours of road labor, and vast quantities of maintenance materials, equipment and transportation facilities needed for war.

Concrete roads in general will carry the *heaviest wartime traffic, with the least upkeep cost and the least wear and tear.*

Concrete is helping economically to build needed strength and stamina into main-traveled military and access roads—with little or no steel, and generally with minimum use of transportation facilities for construction.

Our technical staff is ready to assist designers and builders on paving and all types of war construction. We ask that you let us supply any data that will expedite your job or help get maximum service from concrete.

PORTLAND CEMENT ASSOCIATION
Dept. A1d-170, 33 W. Grand Ave., Chicago, Ill.

A national organization to improve and extend the uses of concrete . . . through scientific research and engineering field work

★ ***BUY MORE WAR SAVINGS BONDS*** ★

PICTURED here are some of the many applications to provide heat for industrial buildings and service camp structures where Dravo Heaters were installed and, in many cases, in preference to a central steam heating plant.

Each Dravo direct fired heater is a self-contained unit with its own combustion chamber, motor and fans to circulate the warm air in the space to be heated. One or more of these heaters can be arranged to heat buildings of any shape.

Such a system is quickly installed, furnishes instant heat and represents a substantial saving in manhours and scarce metals over a central steam heating plant and necessary distributing system.

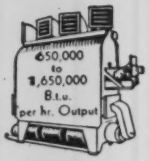
Types for any application—models for all fuels—request Bulletin 505—or consult "Sweets."

DRAVO CORPORATION

Heater Department

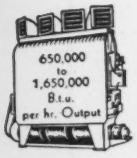
DRAVO BLDG., PITTSBURGH, PA.

Forty-seven Sales Offices in Principal Cities

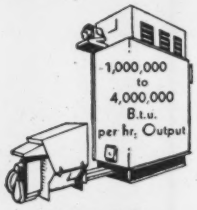


OIL

DRAVO DIRECT FIRED HEATERS



GAS



COAL

WILLIAMS *Buckets*

Welded Rolled Steel Construction

All types and capacities for all conditions. Send for Catalog.

The Wellman Engineering Company
7000 Central Ave., Cleveland, O.

built by **WELLMAN**

EPPINGER AND RUSSELL CO.

Wood Preservers Since 1878

All kinds of Structural Timbers and Lumber Pressure Treated with Creosote Oil or

DU PONT CZC Chromated Zinc Chloride

80 EIGHTH AVE., NEW YORK, N. Y.

POLES, CROSS ARMS, PILING, TIES
POSTS, BRIDGE AND DOCK TIMBERS

TREATING PLANTS

Jacksonville, Fla. Long Island City, N. Y.

tions, war housing, wage stabilization, the Alaska highway and the 1943 Minnesota highway department program.

D. W. Kimball, of Washington, president of the A.G.C., spoke on the future of construction and H. E. Foreman, managing director of the national organization, discussed "The Washington Situation." H. W. Richardson, western editor of *Engineering News-Record*, was a featured speaker describing the Alcan highway.

Other speakers included M. J. Hoffman, state highway commissioner.

CONSTRUCTION business in the United States during 1943 may be considerably lower than the volume for 1942, H. E. Foreman, managing director of the National Associated General Contractors told the annual conventions of the central branch and the Master Builders Association of Iowa in a recent joint meeting at Des Moines. Mr. Foreman shared the convention program with Dan W. Kimball, president of the A.G.C., who spoke on the work of the national group.

New Central Branch A.G.C. directors who were elected at the meeting are: E. B. Spencer, of Waterloo; F. H. Carlson, of Decorah; W. G. Scothorn, Cherokee; L. Peterson, Cedar Rapids and O. F. Paulson, Cedar Rapids.

The branch re-elected Edgard M. Dusenberg of Mason City as president. Mr. Spencer and Mr. Carlson as vice presidents, and Paul B. Reis, Des Moines, as treasurer.

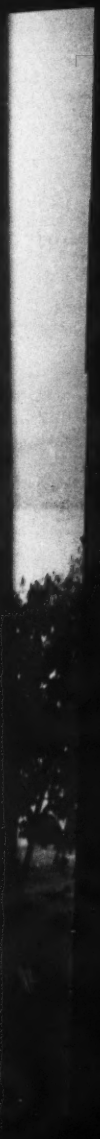
NORRIS RUSSELL has been elected president of the Charlotte, N. C., Engineers Club. Other new officers are: H. B. Wolf, vice president; C. M. Stone, secretary; and C. W. Underwood, treasurer.

J. FRANK JOHNSON, chief engineer, New York City public works department, has been elected president of the Municipal Engineers of the City of New York. Other officers elected were: Andrew Biagini, first vice president; Homer R. Seely, second vice president; Alfred Brahdy, secretary; Ernest F. Fox, treasurer.

E. B. BLACK, president of the American Society of Civil Engineers, recently addressed members of the Oregon section of the society at a meeting held in Portland.

THE Southeastern Association of State Highway Officials will hold its annual meeting in the Hotel Patten, Chattanooga, Tenn., Feb. 16 and 17, to discuss ways and means of cooperating in meeting war requirements. Speakers on the program will include a representative of the Army, Public Roads Administration, American Association of State Highway Officials, the Tennessee Valley Authority, and highway officials of Southeastern States.

E]

N]

engine